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Gear Teeth Are Readily Hardened by Means of Straddle-Type Heads

(See article in this issue on "Oxyacetylene Surface Hardening," page 535)

VOLUME 60
No. 7

MECHANICAL ENGINEERING

JULY
1938

GEORGE A. STETSON, *Editor*

History of a Culture

D. C. JACKSON performed a useful service to engineers when he delivered a series of six lectures entitled "Engineering's Part in the Development of Civilization" at Raleigh, N. C., last January; and in order to reach a larger audience, he has consented to their publication in MECHANICAL ENGINEERING. In this issue, therefore, the series begins with the appearance of the first lecture on "Civilization, Engineering, and the Earliest Men."

Anyone who knows the author of these lectures, and few there are in engineering circles who do not, realizes that anything the distinguished professor emeritus of electrical engineering at the Massachusetts Institute of Technology has to say on such a subject ought to be heard. With a lifetime of engineering practice and contact with young men as a background, Dr. Jackson has given expression to the results of years of reading and study of a subject too few engineers have troubled themselves to investigate. The broad panorama which he has sketched, reading back into the dim regions of prehistory, is unrolled in the lectures so that young men and busy practitioners may scan it with a minimum of effort. Throughout this panorama is repeated the central theme announced by the general title of the series. "True civilization," he says in the introduction to the lectures, "is dependent on the fruits of engineering, but it cannot be brought to full embodiment any faster than the manifest intelligence of the people leads the procession toward it." This single sentence gives expression to the essential truth that history teaches about the material aspect of the evolution of society. It is a pronouncement of a matured judgment. It is a fact which all engineers, particularly those who are about to enter practice, should keep clearly before them. It acclaims engineering as a major cultural force. It implies a vast social responsibility laid upon engineers. It explains why advancement toward civilization's goal is not more rapid and more sure.

Some day our educational institutions will pay more attention than they do today to the interpretation of history that Dr. Jackson has undertaken. In spite of curricula that year by year become more crowded with the study of technical subjects, room will be found for a consideration of the arduous path by which mankind has traveled from his prehistoric to his present elevation in order that engineering may acquire, in the thinking of those who practice it, the dignity and significance to which it is entitled. Although it is popular to scoff at the past, to prattle boastingly of faces set toward the future, a better social order will be achieved by men who have perspective and understanding. Looking backward over what Albert Galloway Keller calls "Man's rough road," will serve to smooth the road ahead, teach needed lessons of patience and humility, and explain the stubborn irrationalities of life and men.

Our educational institutions will also develop a new field of instruction for those who do not study for engineering careers. They will trace out for nonengineers that thread of material and technological development which is woven into the fabric of life in increasing quantity. Where do the major problems of modern life, be it local, national, or international, have their roots if it is not in the fertile soil of engineering? But what hope for universal peace and good will is there that is not strengthened by the mechanisms and the material abundance and economic security that the culture of technology provides? If, as Dr. Jackson points out, the origins of social life lay in man's ability to contrive tools, processes, and structures, will not its further flowering be aided by further wise development? If we have progressed so far from the times when individual existence seemed to depend upon superiority of tooth and claw, shall we not proceed further through dependence on the intelligent use of technology?

No one, least of all Dr. Jackson, would hold that technology is all. What is urged is that there is a lack of appreciation among engineers and laymen alike of its cultural value and the part it has played in our development. Dr. Jackson's lectures should be "required reading" for engineering students.

Confession and Acknowledgment

PROBABLY relatively few members of national engineering societies realize the extent and value of the interchange of courtesies that goes on constantly between the headquarters staffs of the Founder Societies. Undoubtedly, no single influence contributing to this highly desirable spirit of cooperation was more effective than that exerted by the late Calvin W. Rice, for more than a quarter of a century secretary of The American Society of Mechanical Engineers. His vision and practical idealism created an atmosphere of harmony and helpfulness that has become traditional at the Engineering Societies Building in New York. It will some day

be acknowledged as the great spiritual factor in the approach to unity in the engineering profession of which the building itself is today the most conspicuous physical symbol.

Examples of the practical application of this spirit of unity and cooperation in the societies are to be found in this and the May issues of MECHANICAL ENGINEERING. In these cases, which involve simultaneous publication by two societies of papers originally made available to one of them—the paper by Frank L. Eidmann in our May issue and that by Harrison W. Craver published this month—Charles F. Scott deserves a large measure of credit. But Scott and Rice share also the credit for the Engineering Societies Building, because they shared in the early part of the century the common ideal of unity and cooperation. It was Professor Scott's appeal to the editors of the Founder Societies that they make available to one another articles of common interest to the engineering profession that prompted MECHANICAL ENGINEERING to send galley proofs of Professor Eidmann's address, published in May, to the other three society journals, as well as that of the S.P.E.E., and that led *Electrical Engineering* to return the courtesy when Dr. Craver's address, to be found in this issue, fell into its hands.

Since the spirit of this comment is one of confession and acknowledgment, let it be extended to include all sources whence MECHANICAL ENGINEERING derives the material it offers to readers, and particularly to the magazines from which the abstracts appearing in "Briefing the Record" are prepared. MECHANICAL ENGINEERING is a channel through which flows a stream of useful knowledge originating in numerous sources in addition to that represented by the activities of the A.S.M.E. A negligibly few engineers have easy access to all these sources. In the spirit of one of the announced objectives of the Society—the dissemination of knowledge—the apparent duplication, which for the average reader does not exist, is countenanced. Like Kipling's Homer, "he went and took the same as me." Each magazine makes this confession, but each hopes that its contribution of original material to others more than compensates for what it appropriates, with credit, let it be remembered, from its contemporaries. This is a practical working out of the principle of unity and cooperation which Calvin W. Rice fostered in the engineering profession, and which Dr. Craver commends to libraries.

Engineering in Health and Safety

LAST month there were quoted in the section of this magazine devoted to the progress of technology and captioned "Briefing the Record" excerpts from an address on biological engineering by Karl T. Compton, president of the Massachusetts Institute of Technology and a member of The American Society of Mechanical Engineers. Among other points made by Dr. Compton was one to the effect that the progress of medicine was being greatly assisted by men of engineering training and by the application of engineering principles, practices, and equipment. More recently, at the dedication of the Benjamin Franklin Memorial of The Franklin Institute, in Philadelphia, Willis R. Whitney, vice-president in charge of research of the General Electric Company, spoke on this general theme in discussing certain biological implications of electricity. On the same occasion Harvey N. Davis, President of The American Society of Mechanical Engineers, in an address on engineering and health, without trying to minimize the "magnificent achievements of the medical profession," suggested that engineers were "contributing quite as much to the promotion of health as are the physicians."

Testimony from such eminent authorities lends weight to the evidence that has frequently been adduced in these columns to the effect that the fields of engineering and the biological sciences are rapidly expanding to encompass common sectors of human knowledge and effort and hence are bringing the toilers in these fields into closer relationship with, and dependence on, one another.

In the sense in which Dr. Davis is reported to have spoken, engineers have found themselves in this field through their development of such devices that promote the public health as improved methods of heating, street paving and cleaning, sanitation, and water supply, to mention but a few. It may be further pointed out that the hazards to safety of life and health that result from machines and industrial processes have also placed the engineer in the position of working with the medical profession.

The roster of such hazards and ways of guarding against them is a long one and almost endlessly varied. Starting with a considerable number of occupational diseases and proceeding to such purely mechanical devices as safe structures, the braking of fast-moving vehicles, and the guarding of dangerous machinery, the mind quickly conjures up example after example in which a lively sense of self-preservation and social responsibility has led engineers to consider not only the benefits of technology but the control of its abuses as well. The great field of opportunity in which the public's share of responsibility outweighs that of the engineer, is in minimizing the purposeful destruction and exploitation that new and powerful mechanisms provide for unscrupulous men. Not the least of these is war itself.

It is a fact of which The American Society of Mechanical Engineers is justly proud that it has always been in the fore in the fight for safety and the beneficent influences of advancing technology. One has only to recall the numerous safety committees and the codes they have developed, the serious consideration given to such social abuses as atmospheric pollution and unnecessary noise, the improvements in machine design, in working conditions, and in work places, leadership in that fertile field of industrial management and personnel relations, and the almost continuous expression of high idealism in professional responsibility by eminent engineers since the formation of the Society, to convince himself that what Dr. Davis has pointed out constitutes a particularly bright page in the history of The American Society of Mechanical Engineers.

ENGINEERING'S PART *in the* DEVELOPMENT *of* CIVILIZATION

By DUGALD C. JACKSON

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INTRODUCTION

WE ENGINEERS give relatively little thought to the broader problems of civilization and usually are as obtuse to its origin and serviceableness as Gus, the lumberjack of tradition, was to pajamas. After the breaking-up of winter in the woods he came into town with money in his pocket and was loafing around a general store where the proprietor was opening some cases of newly arrived goods. "What's them in that box?" Gus is alleged to have asked. "Suits to wear at night," said the proprietor. "They are called pajamas. Will you buy a suit?" "No, siree," said Gus, according to the story, "I ain't no socialite. I don't want them clothes. I goes to bed at night!"

As far as knowing the facts of civilization, the way it came about, and the way it fits, we are a good deal like the traditional Gus with respect to the pajamas, we "goes to bed at night," notwithstanding that engineering is the hand-maiden of civilization.

In these lectures it is endeavored to look squarely at the conditions that have brought about modern civilization, and also to look at its present status. Probably every one of us has thought idly about civilization and most of us have turned it off by reflecting that we are in civilization, and "that's that." We are more or less like the boy who, in Sunday School, was asked whether he believed in baptism. He promptly answered, "Yes sir, I do. I have seen it done."

In order that we may have the background against which to show the effect of engineering on the development of civilization, and our responsibility to civilization, it is needful to follow the threads of development of man. This means that we must follow the expositions of archaeologists and anthropologists; who have worked so industriously during recent decades and have uncovered persuasive facts regarding the prehistoric period, and then follow through the thousands of years of recorded history relating to the affairs of man until we arrive at the present time. If it occurs to any reader that the treatment appearing in these lectures is materialistic, let him remember that intellectual and material welfare go hand-in-hand, and that civilization grows out of their joint effect on sympathetic and mutual relations of men.

The lectures begin with the first development of man, as a background for the main topic, with which are inserted some pertinent questions that should be answered and some definitions. In regard to the definitions, it is to be remembered that they are not formulated idly for the purpose of giving a foundation for argument but are expressions of the best established thought in current usage and in authoritative pertinent literature. Then we arrive at the extraordinary situation when man's intelligence had become sufficient for him to "begin to write." Thereafter "readin', 'ritin', and 'rithmetic" played a strong part in man's affairs. At this juncture it is seen that the foundation for crudely applied ethical principles and rules of morality followed in the wake of community life which was made possible through crude engineering. The germs of civilization thus are seen to have been planted through the need of respectful mutual relations among people who were enabled by means of engineering to join in a community life.

The achievements of civilization toward the welfare of most people were but slight before the Dawn of History, but security of life and livelihood was improved for some through village life made possible by man's crude engineering. That was a great gain for prehistoric man; and, accumulating on that, additional gains have been secured as man's intelligence has broadened through the historical period. Services and disservices both arose, but the services have become emphasized as fuller applications of engineering have developed. Up to quite recent periods, intellectual men exhibited little interest in the welfare of their associated common people, but the lectures show in their course how this attitude changed and civilization broadened, which broadening was made possible by a broadening of engineering.

Life in prehistoric times brought men to the level of reasonably good artisans, using stone and metal tools. At the Dawn of History mankind was but at the threshold of intellectual accomplishments of the character of engineering. From that time on, intelligence is shown to take an important control in life; community affairs grow with the spread (and demand for the acceptance) of ethical principles; and civilization moves waveringly forward. With increasing emphasis on intellectual power, man comes to find joy in accomplishment for each individual, which may be caused to transcend the simple grubbing after food and other things, and the excitement of which ultimately may be as influential in attracting votaries as the excitement secured from participating in warfare.

The unfolding of the record shows development of engineering enterprise, community development, increasing contacts between peoples, and a concurrent recognition of ethical principles and morality, in historical time up to and through the first fifteen hundred years of the Christian era, which exceeds the progress of all prehistory. The acceleration has continued to the present day, although war goes on in the eastern part of the world and threatens in the western part. In contrast, never before has a great population been in such good circumstances as the people of this nation in the Twentieth century, notwithstanding our own part in the World War and our inadequate measures for combating the great ensuing depression. It is for engineers to reflect that we have achieved our present fortune, and must look forward to bettering it, through the gradual development of ethical community relations which have been made—and will be made further—possible by the steadily widening structure of engineering. Here is a responsibility which gives notice to each intellectually competent engineer not to speak out too readily in condemnation of the significant features of our present social status, but first to

First of a series of six lectures on this subject delivered at the University of North Carolina State College of Agriculture and Engineering, Raleigh, N. C., Jan. 21 to 29, 1938.

think over possible means for improvement that may prove sound, and then to give constructive voice in the situation.

Our usual rather superficial picture of civilization is too much founded on descriptions of former cultures, which were only partial civilizations because they failed to recognize a general mutuality of interest among men, which full civilization must do. Full civilization comes to us only when we have well developed material and intellectual well-being among large groups of people, and to get this requires the contributions of engineering. The establishment and maintenance of community life depend on engineering. Ethical and moral needs arise out of community relations to make civilization. Thus, true civilization is dependent on the fruits of engineering, but it cannot be brought to full embodiment any faster than the manifest intelligence of the people leads the procession toward it.

The often heard doctrine that civilization is declining is not new; neither is it sound. It has been announced from time to time by philosophers for untold generations during the latter period covered by the written records. Were this doctrine of pessimism correct, civilization would have long since faded away and we would have no civilization today. This series of six lectures is a preliminary outcome of much arduous reading, note recording, study, and reflection relating to the development of civilization among men in prehistoric and historic times. The observed conditions lead to the tenet that civilization and engineering have originated and developed side by side, and that engineering has been the hand-maiden of civilization. As a particular corollary, the conclusion arises that germinal engineering was essential to the origin of civilization and that a broadening and improvement of civilization (with its enlarging view of ethics and morals) has occurred down to our day, with dependence upon a collaterally growing and broadening engineering. We enter the future in that trend of progression.

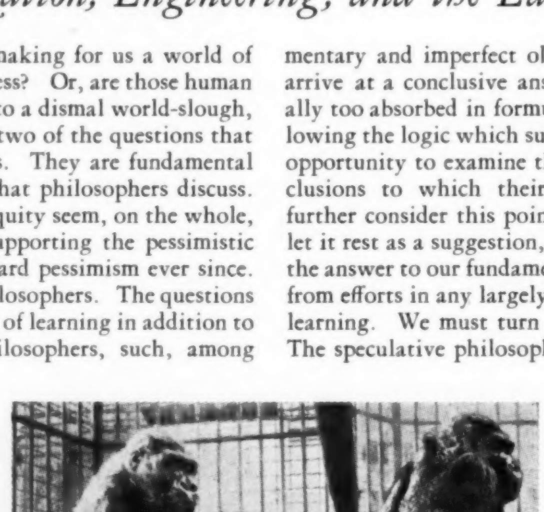
The ensuing material having been cast in the form of oral lectures, rather than a treatise, accounts for the repetitions made for the convenience of somewhat changing audiences, and for the particular subdivisions adopted. The author hopes that these conditions will not lessen either the lucidity or the interest for readers. The lectures were prepared and delivered at the invitation of Dean Blake R. Van Leer, of the College of Engineering of the University of North Carolina. The pressure of condensation required to bring the topic within the compass of six lectures has made it necessary to omit bibliographical references to original sources except where direct quotations have been made.

I—Civilization, Engineering, and the Earliest Men

Are human efforts at civilization making for us a world of slowly increasing comfort and happiness? Or, are those human efforts leading us only more deeply into a dismal world-slough, full of devils' hoofprints? Those are two of the questions that come into the fabric of these lectures. They are fundamental questions relating to human affairs that philosophers discuss. Such philosophers as arose in far antiquity seem, on the whole, to have tended toward an answer supporting the pessimistic side, and philosophy has tended toward pessimism ever since. But we must not rely solely on the philosophers. The questions have been claimed also for other fields of learning in addition to the field of speculation of the philosophers, such, among several, as the fields of observation and study of economists and sociologists. However, the answer has not come out of any of the several such groups of scholars, in spite of their many attempts.

When the answer is conclusively given, if it should favor the second or pessimistic half of the double query, there then arises the crucial question, "What, if anything, can be done to head off disaster to civilization?" If the answer should favor the first half of the double query, then the question becomes, "How can we speed up the process of improving civilization and thereby more quickly provide for the world more comfort and happiness?"

With an emphatic disclaimer of any intention to be flippant, I will venture the suggestion that, for the moment, sociologists are too much impressed with their conclusions drawn from very fragmentary and imperfect observations of present-day affairs to arrive at a conclusive answer, and that philosophers are usually too absorbed in formulating independent premises, and following the logic which supports their reasoning, to allow them opportunity to examine the practical applicability of any conclusions to which their reasoning leads them. We shall further consider this point later in these lectures but here can let it rest as a suggestion, along with a further suggestion that the answer to our fundamental double query is not to be secured from efforts in any largely speculative or transcendental field of learning. We must turn into other paths to seek an answer. The speculative philosophers tell an intellectually interesting story which describes the fabric of civilization; but it is the inductive reasoners, i.e., investigators in the fields of science, inventors, and engineers, on whom the weaving of that fabric has depended and continues to depend. The philosophers, the sociologists, and the economists are the descriptive artists and decorators of the fabric.



. . . . . a gorilla is said to be very powerful and dangerous when erect, but does not continue long in such a posture. With a maintained erect posture structural changes occurred in the body, and *homo sapiens* ultimately emerged from more primitive near-human life.
(From Bulletin of Zoological Society of Philadelphia)

With complete confidence that an answer can be found to the fundamental double query and that some light then may be thrown on the collaterals, we turn to the historical route of inquiry and try to determine what truly has been the fundamental support for what we call civilization. We know empirically that we cannot successfully forecast the future without first tracing the course of the stream of knowledge through the past, even going in the effort back to the springing sources of the stream; and then,

carrying the forecast forward on extensions of the curves showing antecedent progress, with corrections for refraction in crossing the level of the present, the forecasts may be somewhat reliable. This is equally as true of social as of physical science, and also equally true whether we consider single phenomena or whole branches of learning.

Thus, for the purpose of these lectures, we turn from the speculative and transcendental branches of learning toward more concrete and empiric routes. Moving thus, we may take up the influence of science and invention and trace the effect of that influence on conditions surrounding human life and the development of civilization. By following that course, we may observe trends from whose indication we may wrest the tentative answers to our questions. The outpourings of no single group of intellects can satisfy our needs in this quest, but we must trace the whole path of the development of civilization, beginning with the scant inferences arising from remains that indicate human conditions which existed through tens of thousands or even hundreds of thousands of years, and that ultimately developed into records leading to our time. This is a path with inferences at its origin, but one which leads through gradually widening records and speculations until it terminates in the recorded state of human affairs at the present day.

In a series of six lectures, it is not possible to lay down a documented map of the path which we are tracing, or note in seriatim its important landmarks. Only a treatise can encompass all those things; but we will have here a digest and interpretation instead of a treatise. However, any dating that is noted in these lectures is an interpretation of established geological and archaeological data.

IMPORTANT TERMS ARE DEFINED

Before plunging into the little charted wilderness of prehistoric times, as we must do in pursuance of our purpose, it seems important to set several bench marks in the form of definitions. What do we mean by the words science, invention, engineering, artisanship? Also, what do we mean by civilization? These are common words, in general use, each of which has a range of rather loosely attached meanings. We must use each one with a single definite meaning of importance which normally attaches to it. Craving pardon if I weary you, I here give those distinctive meanings.

Science is organized knowledge, and as such it is derived inductively from controlled observations of individual natural phenomena and the relationships of such phenomena. You observe that this definition excludes deductive speculations; although such speculations often are helpful in leading inquiry toward scientific observations. It may be added that physical science deals with nature and man's relations with nature; social science deals with man and man's relations with man; and that these two possess fields which overlap here and there. In fact, they come into intimacy in the structures of engineering and of preventive medicine.

Invention is the process of reasoning from the results of observations to special applications which are of human use, and to modifications of one set of useful applications into others. Invention may relate to conceptual ideas, to elementary devices, to practices, or to machines; however, purely speculative ideas are excluded. Invention has been a most active influence in changing the living conditions of man in directions which have aided the development of civilization.

Engineering is usually defined as the art of directing the forces of nature for the service of man, but it needs to be more concretely described for our purposes here. It is a process of planning, organizing, and executing work, such as comes within the aforegiven usual definition, and is distinguished from artisanship by its demand on the intellectual qualities of its practitioners. Engineering is a profession which requires highly developed inductive intellectual qualities. It is a scientific profession, but has great influence on political economy. It rests on observation, scientific discovery, and invention. The qualities of invention are constantly utilized by engineers, although inventors need not always be engineers. The processes of scientists also are constantly utilized by engineers, although scientists need not be engineers. Similar intellectual qualities and imagination are required of engineers and scientists. The distinction between the two groups of men lies in tastes and individual interests.

Artisanship is the practice of some mechanical art that is a handicraft. It usually originates from observation of similars or from the trial-and-error, cut-and-try process. As such, it may or may not involve much effort beyond that pertaining to exercising manual skill. In those instances where considerable intellectual effort contributes to the products of artisanship, the field of artisanship may overlap somewhat into the zone of engineering. The earliest engineers apparently were self-developed from the ranks of artisanship after the break of dawn from a crude early life into an age of intellectual curiosity and inductive reasoning. This route for growth into engineering became more difficult to traverse as the structure of science expanded; and, during the past century, formal engineering education grew up, in which the fundamental physical sciences and the processes available for making useful applications are emphasized.

Civilization means an advanced state of material and social well-being among men, which is associated with a sympathetic mutual interest between individuals and by individuals for community welfare. It connotes a developing or developed sense of comity among men. Its grounds for cultivation were prepared when man entered upon the domestication of animals and the practice of agriculture; and its seeds were sown when men possessing like objectives first purposefully gathered together in communities made possible by some developed engineering sense. The mutuality of interests which arises from integration of communities within themselves and among each other follows in the wake of the great inventions which either make personal relations among men important for comfort and convenience or make such relations easier to secure, and, at the same time, lift burdens from the muscles of individuals.

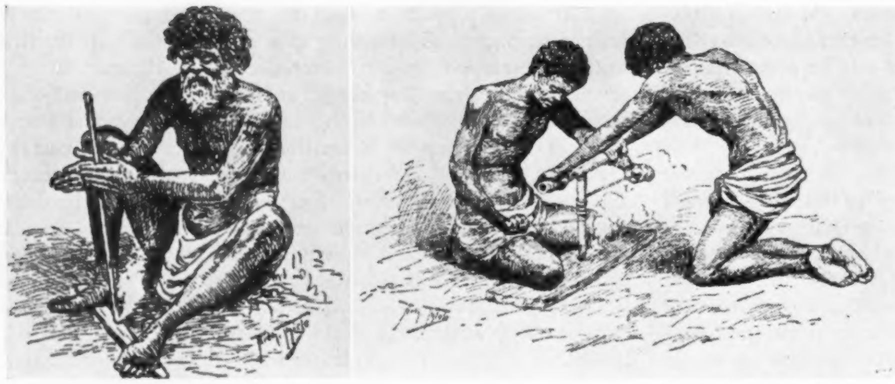
Permit me to point out here that the material and physical aspects of civilization are in constant flux as scientific discoveries increase the possibilities of physically comfortable and secure living. Because of the increasing emphasis on mental activity compared with purely physical activity which these enlarged possibilities bring to pass, the intellectual aspect of civilization, which we call culture, also widens, and binding cords of human sympathy gradually deepen as civilization widens.

CONDITIONS OF LIVING OF EARLIEST MAN

Let us now return to earliest man and trace his conditions of living in the ages prior to the present era of history. Assuming that man evolved from anthropoid stock, geologists have developed certain theories of conditions under which the evolution might occur. There is little except inference or fancy on which to hang such a theory. Indeed, in dealing with all of the prehistoric period we must follow

> "Some chime of fancy, wrong or right,
> Or strong invention,"

but frame each fancy so in keeping with the characteristics of human nature that to our minds it persuasively appeals as right.



. . . . . Control and utilization of fire were achieved in a crude way . . . observation of accidental experiences ultimately brought to man's hand the processes of ignition . . . by the use of friction of wooden pieces.

(From "Childhood of Man," Frodenius)

Equally, we must be cautious, for, as Wordsworth also suggests,

> "Fancy . . . .
> Full oft is pleased a *wayward* dart to throw."

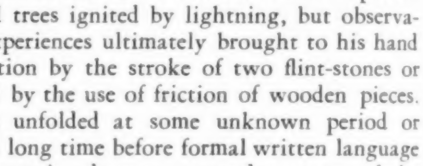
Thus it may be that, under changing climatic conditions, an anthropoid group found that enterprises of offense, defense, and gathering food were more successful with a maintained erect position. A bear may stand and walk erect when excited, and various animals stand erect under various circumstances. A gorilla is said to be very powerful and dangerous when in the erect posture. But no one of these animals maintains itself erect as a continual posture. With a maintained erect posture, structural changes occurred in the body, and *homo sapiens* ultimately emerged from more primitive near-human life.

This emergence may have been many tens of thousands of years ago. It may have been more or possibly less; but on that we are not intent. Our interest is in the manner in which prehistoric men and their successors, through many ages, might live and bring up families of their changing kind. At first, except for a certain degree of superior intelligence which, perhaps, enabled him to coordinate experience more serviceably, primitive man was no better off than the animals around him. He had no control of fire, he had no extrinsic implements, and he had no intelligent speech. He was a plaything of the elements, and his own strength was his sole reliance. The sounds he uttered were expressions of his emotions, such as fear, rage, satisfaction, love, as with other animals. He had no more moral quality than a polished billiard ball, going where he was pushed by circumstances.

Such, presumably, was the beginning life of man. Whether a male with his female or females and children herded alone and in antagonism to others like themselves, or whether several such families lived as a group or clan, will never be known. But by no stretch of the fancy can we conceive among these progenitors of the human race either civilization or engineering, even in rudimentary or tenuous form. Life must have been of a beast-like, precarious, hand-to-mouth character. To live strenuously, with multiplied emphasis on the word strenuously, was the only way to exist. Even for those who thus exerted themselves for existence, it is probable that few came to death by means other than violent ones, as is characteristic of the wild beasts. We may assume that the children gamboled about and secured joy from gnawing bones, snatching roots, seeking berries, wrestling together, throwing stones, and doing other childlike things; that the women found contentment in their association with the men and children; and that the men exerted themselves in capturing animals and fish for food, in tooth-and-claw combat with each other, and in other such male activities. Let us keep these things in mind, for we will revert to them when later considering the effect of civilization on the happiness of the humankind, after civilization finally began to develop.

Prehistoric men lived a life of ever recurring conflict—with nature, with wild beasts, and with fellow men. Food, raiment, shelter were obtained, and life itself was maintained, only by struggle. Whether less strenuous hours ever existed for the early men in prehistory, except in sleep, and that in constant jeopardy, we do not know. However, intelligence came gradually to tell. Control and utilization of fire were achieved in a crude way. The original source from which man secured fire to convert to his use probably was from burned trees ignited by lightning, but observation of accidental experiences ultimately brought to his hand the processes of ignition by the stroke of two flint-stones or flint and pyrite and by the use of friction of wooden pieces. Recognizable speech unfolded at some unknown period or periods, but it was a long time before formal written language emerged. Pictorial remains drawn or carved on some of the ancient cave dwellings are believed to date back several tens of thousands of years; but archaeologists date from six or eight thousand years ago the period during which the art of writing developed, first on stones, wood, skins, bark, clay tablets, and finally on paper.

It is to be borne in mind that in the paleolithic, or earliest period of man, aesthetics, art, and creative endeavor had not stirred appreciably in the intellect of man. Some copying of outlines of live objects to use as talismans, and efforts for securing self-protection, shelter, and bare subsistence, were sufficiently exacting to occupy fully the intellectual possibilities of mankind which then existed. Whatever effort of invention was forthcoming was to abate nuisance, reduce required muscular effort, or conduce to safety. A like situation con-



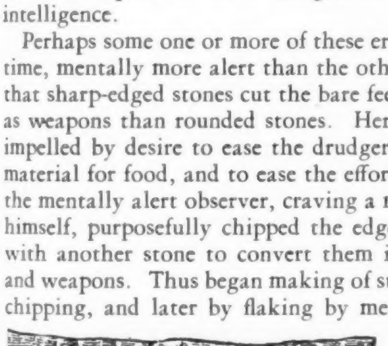
. . . . . as the dexterity of artisanship became established, the mental effort required for invention to avoid physical inconvenience began to be actively practiced. (Eskimo drill for working in iron or bone and for making fire with piece of driftwood *d*. Parts shown are mouthpiece *b*, shaft *a*, with iron or wood drilling tool, and bow and string *c*.)

(From "The Central Eskimo," by Franz Boas, G.P.O., Washington, D. C., 1888)

tinued through a considerable part of the following or neolithic period, but easier conditions gradually appeared as the neolithic age unrolled itself toward the dawn of history. As the dexterity of artisanship became more and more established, the mental effort required for invention to avoid physical inconvenience began to be more actively practiced by the mentally most alert.

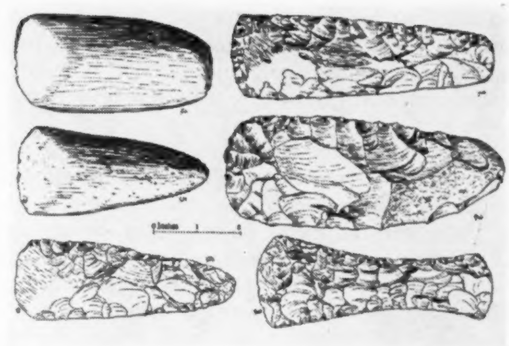
Each such development brought forward a step the possibility of friendly contacts between individuals. In the meantime, some sort of family relations, and perhaps loose tribal relations, grew up. The background was being laid in the interest of germinal civilization and engineering, which were yet to come. Anthropologists insist that the qualitative character of the mentality of the human race changes with extreme slowness, if it changes at all. It is a fact, however, that, quantitatively, intelligence grows with individual experience and observation, when the individuals have normal human brainpower. Experience also impels concentration on the manner of observation. It is a case which may be illustrated by a baby who first feels an impulse to walk. He begins by standing up or trying to stand up, and he promptly falls down. Trying and retrying, he improves until he stands and finally takes unaided steps. By the secured experience and observation, his intelligence is aroused and informed until it becomes able to direct the efforts to maintain a physical balance. In an analogous manner, mankind, as a race, has slowly progressed as observation and experience have enlarged the effectiveness of human intelligence.

Perhaps some one or more of these erect beings of prehistoric time, mentally more alert than the others, repeatedly observed that sharp-edged stones cut the bare feet or were more effective as weapons than rounded stones. Here came a thought; and impelled by desire to ease the drudgery of digging or cutting material for food, and to ease the effort of offense and defense, the mentally alert observer, craving a muscularly easier life for himself, purposefully chipped the edges of stones by striking with another stone to convert them into cutting implements and weapons. Thus began making of stone implements, first by chipping, and later by flaking by means of pressure, and by grinding and polishing. It must have been many tens of thousands of years ago. The results were very crude at first, but experience over a period of thousands of years brought improvement until the last races who made stone implements did a fine job. Indeed, the making of stone implements became somewhat centralized in certain places where particularly desirable stone, such as flints, proved to be available; and some individuals apparently specialized on the making of implements. It thus appears that "division of labor," which is sometimes talked of as though it were an outcome of the use of machinery and, therefore, a modern phenomenon, is in fact very old and indeed proves to be a simple outcome of human experience.



. . . . . the making of stone implements became somewhat centralized . . . where particularly desirable stone, such as flints, proved to be available. At the flint mine, Mur de Barrez Averron, France, the primitive miner dug till he reached level *E*, where the bed was mined through its entire length. (*C*, calcareous formation; *s*, beds of flint; *P*, filled-in pit; *d*, clays and gravels; *c*, deposits of carbon on floor of *E*.)

(From "Human Origins," by G. G. MacCurdy, D. Appleton & Co., New York, 1926)



. . . . the mentally alert observer, craving a muscularly easier life for himself, purposefully chipped the edges of stones . . . to convert them into cutting implements and weapons . . . .

(From Burkitt's "Our Early Ancestors," Macmillan Co., New York, 1926)

Division of labor, which thus originated with primitive man as an outcome of the effort to do things with the least practicable exertion, is still with us in our most modern processes of production. It probably will continue to exist as long as man is called upon to do either manual or mental labor. We retain it for the same reason that primitive man originated it, that is, to secure accomplishment with the minimum of exertion. The thing that is new in our modern day is "adaptation of labor," a phrase which means the condition wherein engineering invention is used to shift the heavy labor from the muscles of individual men onto machines. Along with this adaptation, which is an engineering development of quite recent times, goes a greater emphasis on intellectual power. That aspect of engineering primarily arising from a recognition that the dignity and power of the human mind makes it appropriate to relieve man labor by machine labor in drudge work is of later acceptance.

STRUCTURES, PROCESSES, AND MACHINES MARK BEGINNINGS OF ENGINEERING

Tools and simple weapons are evidences of artisanship. We must seek for the trail of structures, processes, and machines in order that we may trace the development of civilization, which accompanied the development of engineering as distinguished from artisanship. This planning and erection of simple structures came quite early, and simple processes, like certain elements of metallurgy, followed, but the development of machines apparently lagged. The effort required for combining mechanical elements into machines demands a deeper intellectual effort than is required to make rudimentary surveys and plan rudimentary structures. The archaeologists' deciphered records of machines only go back for periods of some thousands of years. The advantage of differentiating between implements of like kind according to their intended use, by making variants for different kinds of use, seems to have been recognized very early. An example is a variant of arrows provided with stone heads in the stone age, which, it is inferred from what data exist, were so made that war arrows left the head in the wound when the shaft was withdrawn and hunting arrows could be withdrawn from the stricken animal with the head intact. Contrastingly, the creative intellectual quality required for the invention of machines proved too abstruse to become stirred until the friction of inconveniences in community living became the cause of much mental warmth in the sluggish primitive mind.

The so-called mechanical elements (the wheel, the wedge, the lever, the screw, the pulley) apparently were in use in prehistory, as is shown by their appearance in early drawings in the historical era; but when and where they were first used has not come down to us.

The utility to be derived from the wedge and the lever probably was recognized for each, even by primitive minds, at an early time. It is more difficult to picture the origin of the screw or the reasons impelling its invention among these mechanical elements. It is an extraordinary contribution to muscular relief which we now take for granted as though it were a part of original genesis, and it comes as a tool to us moderns, along with the other mechanical elements, from the musty ages of unrecorded history.

If, as ethnologists tell us, human intelligence has not changed in qualitative character over long ages measured in tens of thousands of years, we can picture inferentially a possible mode of development of the wheel and its application to vehicles. This possible path for the invention is easily traced in the light of our present modes of mental reaction. Nomadic habits appear to have begun very early for some groups of primitive men with their families, and we can picture the discontent of the most mentally active men, even in a crude and unformed race, as they, season after season, faced the inconveniences and wear-and-tear of family movings across country. The physically indolent but mentally keenest of the men became wearied of dragging individual belongings, or of having them half carried by domesticated animals, or of transporting them on the backs of women and children, or of loading the personal riding horses with goods. The delays and entanglements pertaining to such transport naturally added to the annoyance. The weariness arising from such experiences must have sunk to the soul of some such men; desire for release from the deadly annoyance must have fired their minds; and invention followed as times progressed. Sleds are known to have been used in the early ages. Loose rollers were also utilized. Then controlled rollers and other such expedients may have been tried. Finally, two sections sawed off the end of a roller and mounted on the ends of a wooden trunk gave the wheels-and-axle structure, and the two-wheeled cart was on the way.

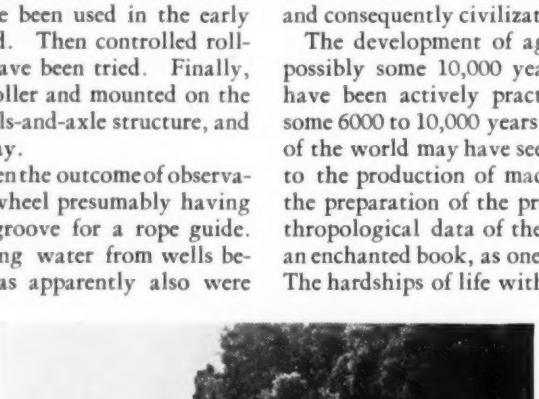
The wheel *per se* might also have been the outcome of observation of pulley operation, the pulley wheel presumably having come as an improvement on a plain groove for a rope guide. Ropes and pulleys were used for raising water from wells before the dates of historical records, as apparently also were chains of buckets. On the other hand, the pulley wheel may have been merely the adaptation of the general wheel to a specific location. Many specific applications of the wheel seem to have occurred. For example, the treadwheel, applied to raising water for use on the land, was used in prehistoric times. On what meager evidence exists, MacCurdy dates the wheel as a neolithic invention. It could scarcely be earlier, and early drawings give the impression that it was in use at the time history dawned.

Conditions for the progress of man seem to have been favorable in many locations within the subtropical and warm-temperate areas of the earth, and the prehistoric development described has left its marks in every continent in the form of prehistoric artifacts and bones of prehistoric man, but the richest deposits seem to have been found as yet in Southern Europe, Egypt, Palestine, and Mesopotamia. It is in these regions that we may profitably analyze further developments. In the World War, it was the unceasing effect of the mud, the wet, and the cold that ate into the morale of soldiers in the trenches of France—not being shot at, as some might think. The latter raised men's fighting blood; the former was unceasingly depressing. In cold latitudes, prehistoric man must have felt some of this effect when winters came. The moderate climates were his best habitat, but our climatic relations have changed during the geologic ages.

The Stone Age merged into the Bronze Age or the Iron Age, and the Bronze Age also into the Iron Age, with overlappings and irregularities, but with general improvements in the conditions of life. In the meantime pottery had come in, at first sun-dried and later fired. Tendencies toward community dwelling appeared, as is shown by the lake-dwellings of Switzerland and elsewhere, and such things as community remains in France and the kitchen middens of Denmark and elsewhere. Crude metallurgy, construction of piled dwellings, village arrangements of huts, and other evidences show that mental force had come to guide the craftsman into the use of combinations of elements far transcending the powers of simple artisanship to plan and satisfactorily to embody. Thus engineering had arisen in elementary form to establish its influence on civilization before the age of historical records opened. The village life thus realized by the application of elementary engineering brought intimate contacts between various families and between individuals of the different families, and the germs of civilization were thus born before the dawn of what is usually called the age of history, i.e., the age for which there is some degree of preserved written records. Ethics and morals arise out of the social contacts in the family, clan, and community; and consequently civilization germinated there.

The development of agriculture came in the neolithic age, possibly some 10,000 years before the Christian era. It may have been actively practiced in Egypt and in Mesopotamia some 6000 to 10,000 years ago, and some other favorable regions of the world may have seen its earlier practice. Agriculture led to the production of machines to aid in the cultivation and in the preparation of the products. The archaeological and anthropological data of these long ages of prehistory read like an enchanted book, as one comes to understand their sequences. The hardships of life with the wicked Bluebeards and the Hansel-and-Gretel witches of more modern times are nothing compared to the beast-like hardships of living in those old times.

As we go on, you will learn that it has been the lot of civilization to make a precarious progress from this germinal time onward, as the age of scientific discovery and invention gradually came to full stature for improving social contacts. Thus the influence of engineering on civilization has been a continuous frontier influence, remembering that it is an intellectual as well as a material influence which we contemplate, and also, remembering that while the frontiersman to some degree wreaks his will on his environment, that very environment influences his intellectual processes.



. . . . tendencies toward community dwellings appeared. Remains of Neolithic lake dwellings at Lake Neuchatel, Switzerland. Decayed ends of piles on which village was built shown as stumps above water.
(From "Human Origins," by G. G. MacCurdy, D. Appleton & Co., New York, N. Y., 1926)

OXYACETYLENE SURFACE HARDENING

By A. K. SEEMANN

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ALTHOUGH THE flame-hardening process has been actively introduced in certain industries during the past few years, there are many who are merely familiar with the terms flame hardening or torch hardening. It is quite necessary that the engineer or designer possess a rather complete understanding of this comparatively new heat-treating process, particularly with regard to its advantages and scope, so that it can be usefully and satisfactorily employed in shop and field.

Paradoxically, flame hardening is at once simple and complex. In its essence, the surface of a quench-hardening ferrous material is raised to the critical temperature and quenched. The chemical composition of the steel is unaltered. Metallurgically, the treatment is the same as furnace hardening, the difference being one of localized, rather than general, heating. The complexities arise in answering the questions of method, depth of hardness, degree of hardness, selection of material, pretreatment, and posttreatment. Fortunately, most of these questions have been answered in whole or part by laboratory or field experience and, therefore, the designer or engineer need have no hesitancy in specifying the process in accordance with the developed data.

THE PROCESS

The flame-hardening process may be applied to any ferrous material which will respond to simple heating and quenching to develop hardness. This, of course, includes the straight carbon steels, a rather comprehensive list of low-alloy steels, cast iron, malleable iron, and carburized materials. In order to produce a surface-hardening effect it is obviously necessary to heat the surface material so rapidly to the critical temperature that the underlying core material will not reach an equal temperature prior to quenching. For two reasons the oxyacetylene flame is peculiarly suited to this function; first because acetylene possesses the highest flame temperature of any hydrocarbon gas and, second, its endothermic characteristics make available an abundance of heat. Actually, it is entirely practicable to produce a hard case $^1/_{16}$ in. thick which means that heating and quenching have been accomplished in a remarkably short time.

Advantages of the Process. One outstanding advantage is immediately evident. The metal can be heat-treated to develop desired core properties, with the assurance that these properties will not be destroyed by the subsequent flame-hardening treatment. The designer frequently desires the combination of a hard wear-resisting surface with a tough shock-resisting core, and while this combination has been obtainable to a degree by carburizing methods, flame hardening offers a great advantage because a selection may be made from a large list of steels, cast iron, and even malleable iron.

The tendency to distort is minimized by the very nature of the process. The fact that heating is localized tends to maintain the surface condition intact because the cool core resists deformation. Generally speaking, the distortion produced is well within manufacturing tolerances.

The fact that the surface of the material is rapidly heated and often drastically quenched would appear to encourage checking or cracking. However, the effects of volume changes are confined to a comparatively thin section and insufficient tensional stresses are created to cause rupture. It has been found that steels sensitive to furnace hardening can be flame-hardened with comparative safety if care is exercised to avoid overheating.

The case characteristics obtainable by the process vary both with regard to depth and degree of hardness. The depth is a function of heating time and can be varied between $^1/_{16}$ in. and $^1/_4$ in. or more. The degree of hardness is a function of carbon and alloy content and the quenching medium. The hardness of flame-hardened articles is at least equal to that of furnace-hardened material of the same composition. It is interesting in this connection to observe that much assistance is given the external quench by the rapid conduction of heat into the mass of the metal. In fact, certain applications are self-quenching; that is, the surface is raised to the critical temperature, the flame is removed, and heat is extracted so rapidly by the relatively cool core that a hardened surface is produced. This points to the ease with which various degrees of hardness can be obtained in one grade of steel.

Let it be assumed that in order to obtain certain core properties a steel is selected which is capable of being hardened to a Brinell hardness number of 600. If the desired surface hardness is 400 Bhn, the quenching may be deferred until some time after transformation has taken place, before applying the coolant to avoid drawing to a lower order of hardness. Similar results are often obtainable through the use of a mild quench, but it is not always convenient to employ a quench other than water. The point here is that the process is extremely flexible and can be varied to produce the desired results or conform with local conditions.

An additional advantage is that the tool can be brought to the work. Articles too large to be accommodated in furnaces are quite as easy to flame harden as small articles, and the portability of the equipment makes it entirely practicable to apply the process in the field remote from any shop or furnace facilities. Thus it is now possible to harden articles which heretofore could not be so treated.

As has already been noted, the results obtainable may be varied by changing the heating time and quenching time. Several other factors also contribute to the final result. The distance of the heating head from the work, the oxygen and acetylene pressures, the quench pressure, the tip arrangement, and the condition of the material each has an effect. These several variables are easily controlled, but it is necessary that they be controlled in order to reproduce consistently the desired depth and degree of hardness.

Materials. While many steels can be flame-hardened, the straight-carbon and low-alloy steels have been found to be

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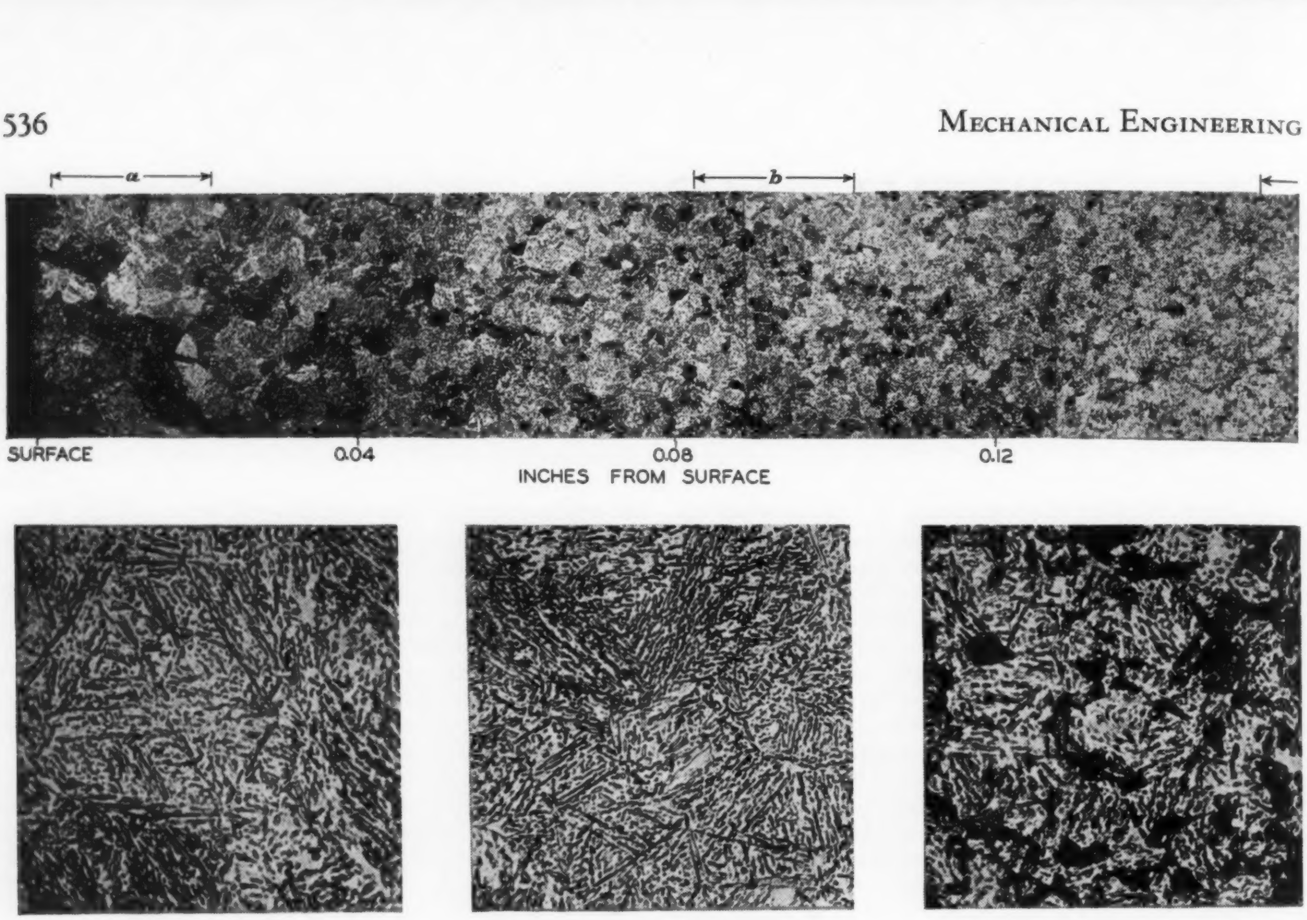


(*a*) TREATED SURFACE

(*b*) MIDWAY BETWEEN SURFACE AND TRANSITION ZONE

(*c*) BEGINNING OF TRANSITION ZONE

FIG. 1 PHOTOMICROGRAPH SHOWING ENTIRE

(S.A.E. 1045 steel, 0.48 per cent carbon, 0.71 per cent manganese. The ductile core of ferrite and pearlite. The

most satisfactory. Steels containing at least 0.35 per cent carbon, either plain or with alloy additions, respond favorably. High-carbon steels and tool steels are easily overheated and will check or crack unless extreme care is used in applying the process. Pearlitic cast iron, either with or without special alloying elements, is rather easily flame-hardened to produce high hardness. Malleable iron has been satisfactorily flame-hardened by so modifying the technique as to permit resolution of the carbon. Allowances must be made for the characteristic decarburized surface by casting a thicker section at those locations subsequently to be flame-hardened. The decarburized surface can be ground off, or be permitted to wear off in service.

The flame hardening of carburized articles offers great advantages in so far as distortion is concerned. Following carburization, the article can be finally straightened while hot. After cooling, it can be flame-hardened with little likelihood that there will be measurable distortion. Obviously, it is not necessary to carburize selectively because the flame will be applied only to those surfaces which require hardening.

Metallography. The appearance and constitution of the flame-hardened case may be described most easily by an examination of etched sections and micrographs from the surface downward to the core material. The photomicrograph of S.A.E. 1045 steel, reproduced in Fig. 1, is typical and shows clearly a fully hardened area about $^1/_8$ in. thick, a transition zone about $^1/_8$ in. thick, and then, unaltered core material. The case thickness and transition-zone thickness can be varied by modifications of the heating and quenching technique.

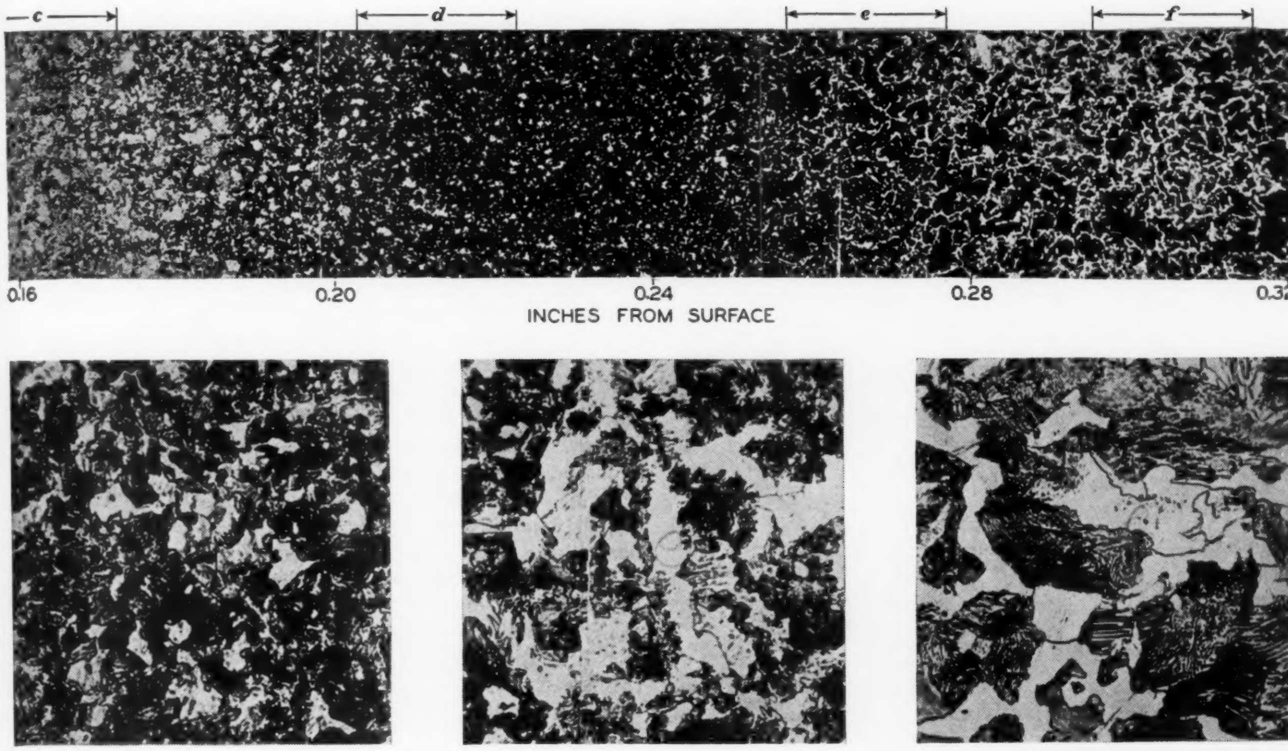
METHODS

Flame hardening is both a maintenance and production process. The nature of the work will indicate whether a simple hand blowpipe or a fully automatic machine is required. Surprisingly good results have been obtained by hand treatment and as an introduction to the simplicity and effectiveness of the process it is suggested that a trial be made by locally hardening a small scrap piece of medium-carbon steel. It is only necessary to heat a small area of the surface with a welding blowpipe or the preheating flames of a cutting blowpipe and then quench with water. The increase in hardness can be tested easily with a file. A number of shops throughout the country use this method to flame harden a great variety of articles. It is interesting to note in this connection that quite frequently the article has worn in service to a degree where it is necessary to build up the worn surfaces with fresh metal. The deposited metal may be one responsive to heat-treatment, such as chrome-molybdenum rod, and after machining it can be flame-hardened. If the metal, as deposited, is too hard to be machined, the hardness can be reduced considerably by local annealing with the blowpipe. This process, known as flame softening, is effective when employed with proper consideration of the characteristics of the metal undergoing treatment.

While a considerable amount of flame hardening has been satisfactorily accomplished by hand, the method is not conducive to consistent results from the standpoint of uniformity either as to depth or degree of hardness. Production flame hardening requires the use of mechanical aids, either manually or automatically controlled. The methods employed are commonly referred to as (*a*) stationary, (*b*) progressive, (*c*) spinning, and (*d*) combination.

The Stationary Method. The stationary method refers to those operations where the blowpipe and work are motionless during the treatment. This is sometimes known as spot hardening.

The Progressive Method. The progressive method refers to



(d) IN TRANSITION ZONE *(e)* END OF TRANSITION ZONE *(f)* BASE MATERIAL

FLAME-HARDENED CASE ×100 REDUCED
structure changes progressively from a hard martensitic surface to a tough
several important areas are shown ×500.)

those operations where the blowpipe and the work move with respect to each other and the metal is quenched as heated. Illustrative of this method is the flame hardening of flat surfaces such as ways for machine tools.

For flame hardening a plane surface, the lighted blowpipe, with a head producing sufficient flame area to cover the path to be hardened, is directed along the surface at the maximum speed which will heat the surface zone above the critical point. Immediately behind the flame is a stream or spray of water which progressively quenches the heated surface. Speed is determined by operating variables such as flame intensity, type of steel being treated, and the temperature desired. It may vary from 4 to 10 in. per min, although the usual speed is from 6 to 8 in. per min.

The blowpipe head should be placed so that the tips of the inner cones are from $^{1}/_{16}$ to $^{1}/_{8}$ in. from the surface being hardened.

The progressive flame hardening of a gear tooth is not only of wide general interest, but furnishes an excellent example of the inherent advantages of flame hardening. The designer desires a hard wear-resisting working face supported by a tough shock-resisting core. This combination is readily produced by flame hardening and, as illustrated in Fig. 3, the contour of the case is of maximum depth at the pitch line, precisely where the greatest strength is needed. A case such as shown is reproducible from tooth to tooth through control of heating and speed of traversing. Gear hardening on teeth larger than 5 diametral pitch, is, as mentioned already, a good example of progressive hardening. Experience has developed certain factors which should be observed in all gear hardening in order that satisfactory service life may be assured:

(1) Shallow cases are to be avoided as potent sources of spalling difficulties. It has been observed that a satisfactory case should equal one third of the tooth thickness, but not exceed $^{1}/_{4}$ in. at the pitch line.

(2) Avoid overheating which produces the conditions necessary to promote checking or cracking.

(3) Do not harden the tops of gear teeth. This condition, if present, is usually found on the ends of the teeth and is caused by a failure to maintain the proper heat balance as the end of the tooth is approached. Typically this condition causes failure by spalling of the end of the tooth along the transition zone.

(4) It is important that flame-hardened gears be carefully aligned when placed in service. The high degree of hardness presents a stiff unyielding surface which will not "wear in" in the same manner as untreated gears. Misalignment produces typical fatigue failure at the root of the tooth as illustrated in Fig. 4.

While a uniform case is to be preferred, experience has shown that this is not a necessary condition for satisfactory service life. Thousands of gears have been flame-hardened by hand with entirely satisfactory results. The variation in case depth and hardness attendant upon hand hardening does not cause differential wear and does not materially reduce the life of the gear.

It has been the practice of many manufacturers to machine heat-treated gear blanks in order to obtain maximum face hardness without further heat-treatment. Flame hardening permits machining steel either fully annealed or heat-treated to produce desired core properties. The saving in machining costs is obvious. One plant reported a machine-shop saving of \$15,000 during the past year by virtue of lower machining costs and fewer gear replacements.

It is of interest to observe that flame hardening fits into the

modern method of gear manufacture employing oxyacetylene shape-cut steel plates welded together.

Spinning and Combination Methods. The spinning method and the combination method are applied to rounds. In spinning, the blowpipe is stationary and the work is rotated before the flames. When the entire area has reached hardening temperature the quench is applied while the work is still rotating. In the combination method the work is rotated before the heating head which gradually traverses the piece longitudinally, followed by the quenching nozzle. It is thus a combination of spinning and progression.

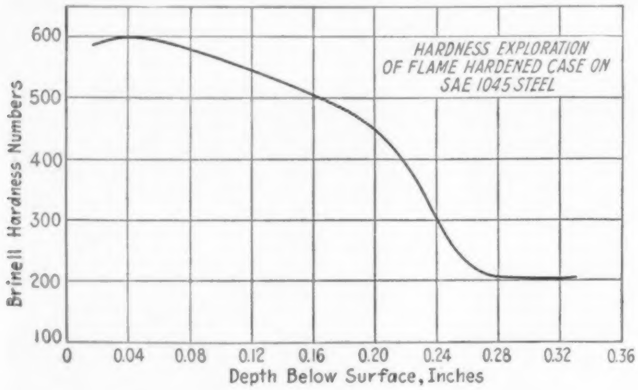


FIG. 2 HARDNESS FROM THE SURFACE TO THE CORE OF FLAME-HARDENED S.A.E. 1045 STEEL SHOWN IN FIG. 1

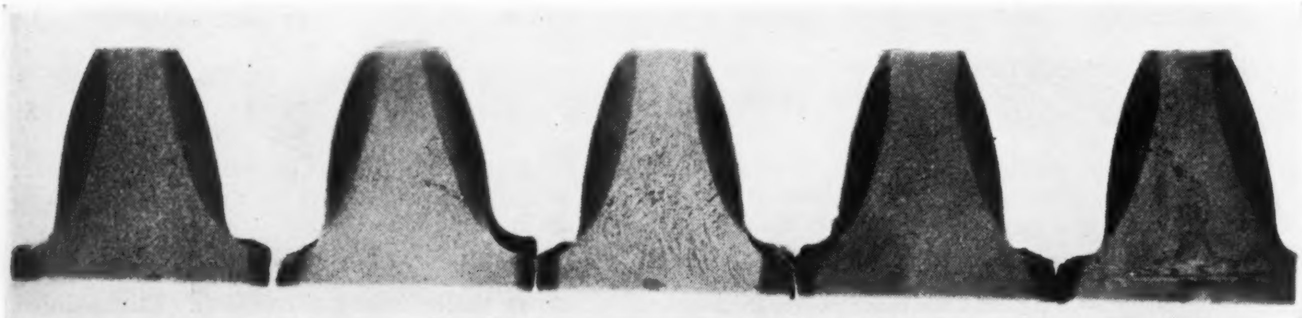


FIG. 3 SHOWING THE UNIFORMITY OF THE CASE IN FIVE POLISHED AND ETCHED CROSS SECTIONS OF THE SAME GEAR TOOTH

The flame hardening of bearing areas is a good example of the spinning method. Sufficient heat is supplied to elevate the entire bearing surface to the critical temperature in not over 2 min (for thin cases the time may be as short as 10 sec), after which it is quenched. To obtain maximum hardness it is essential that the quenching be done coincidently with the removal of the heat source. Fig. 5 shows an etched longitudinal section of the pin bearing of a crankshaft. It is to be noted that the case terminates before reaching the radius and conforms to specifications for depth and contour. The time of heating was 30 sec. In crankshaft hardening, the oil holes should be protected by plugging with carbon paste. This prevents overheating of the edge of the hole.

Roll or Shaft Hardening by Combination Method. The flame hardening of the entire area of shafts or rolls is most satisfactorily accomplished by the combination method. Best results are obtained when the round is rotated in a vertical position, care being taken to center the piece carefully so that a uniform case will be produced. The speed of rotation is not critical and with a well-arranged burner need not exceed a peripheral speed of 50 ft per min. A great advantage of flame hardening in the vertical position is the ease with which uniform and precise quenching can be done. Rounds of various diameters and lengths have been flame-hardened and there does not appear to be any practical limitation to the size or length which can be treated. An advantage of this method is its comparative freedom from distortion. This is explained by the absolute uniformity of heating and the highly localized area heated at one time.

The flame hardening of rolls offers several attractive features. The absence of distortion has already been mentioned. In addition, it is now entirely practical to surface harden large-diameter steel rolls to a depth of $^3/_{16}$ or $^1/_4$ in. with full knowledge that at some later time the roll can be softened by the oxyacetylene flame, machined or repaired, and again flame-hardened. This is an advantage not possessed by chilled cast-iron rolls. The two progressive methods about to be described, while considerably simpler from an equipment standpoint, develop greater distortion.

Spiral and Longitudinal Flame Hardening of Rounds. These two methods are in reality simple progressive hardening. In spiral hardening a single heating head follows a helical path from one end of the round to the other. Longitudinal hardening is done by a succession of passes parallel to the longitudinal axis of the round. The great disadvantage of both methods is the formation of a zone of lower hardness between each pass. While this zone can be held to a narrow width it is objectionable for many classes of service. Both of these methods are extremely

FIG. 4 AN END VIEW OF A FLAME-HARDENED PINION SHOWING FATIGUE FAILURE AT THE ROOTS OF THE TEETH CAUSED BY MISALIGNMENT WHEN THE GEAR WAS INSTALLED IN SERVICE

simple from the standpoint of both oxyacetylene and shop equipment. A single flame-hardening head and an old lathe are ideally adapted to spiraling. The longitudinal method requires only rectilinear motion and may, therefore, employ an oxyacetylene cutting machine or lathe tool carriage.

Circular work of large diameter such as power-shovel roller-path rings are most successfully hardened by heating and quenching during one rotation of the part. Either the work or the heating heads may be stationary. This then is merely an application of the progressive method already described for rounds.

The zone of lower hardness which will be produced at the start and stop point may not only be held to a narrow band, but in addition it may be positioned at an angle so that the line contact of rollers will not at any one instant bear entirely on the softer metal. This expedient has produced excellent service results.

OPERATION

Control of Operation. Descriptions of flame-hardening methods imply mechanical means for guiding the flame-hardening head over the work. The question immediately arises as to whether or not the operation should be fully automatic in addition to being mechanical. In the interests of absolute uniformity the process should be automatically controlled but there is a practical limit to such control. All flame hardening should be controlled by a qualified operator whose duties may range from simple observation of the machine and blowpipe adjustments to full control of the entire operation. Crankshaft or bearing-area hardening is a good example of the former, and roll hardening of the latter. As a matter of record, the best gear hardening has been manually controlled and there are good reasons to believe that this operation will always demand careful supervision on the part of the attendant.

Because the rate of heat input may be carefully regulated, it is necessary to control the time element only, in order to obtain repetitive results of high uniformity. In progressive or combination work this means good speed regulation; in spinning work the operation only need be precisely timed.

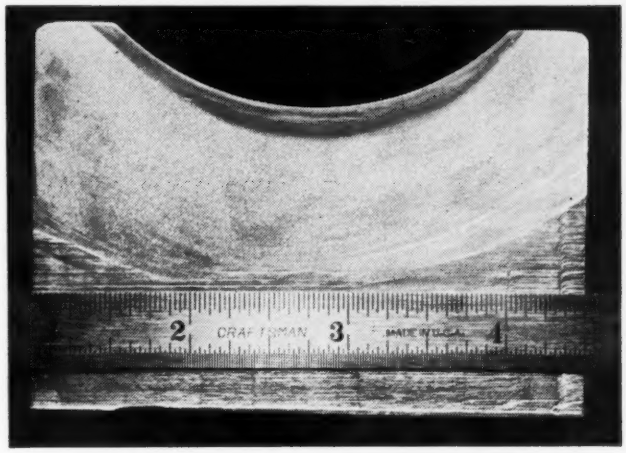


FIG. 6 POLISHED AND ETCHED SECTION OF A GROOVED ROLL AFTER FLAME HARDENING BY THE SPINNING METHOD

FIG. 7 SHOWING THE CORRECT POSITIONING OF GEAR-HARDENING HEADS WITH RESPECT TO THE GEAR TOOTH

(In these heads, the water quenching nozzles are integral with the head.)

FIG. 5 A LONGITUDINAL SECTION OF A FLAME-HARDENED CRANK-SHAFT-PIN BEARING WHICH HAS BEEN ETCHED TO SHOW THE CASE

(Note the uniformity of the case in the region of the oil hole.)

Apparatus. From a description of the methods, it is apparent that many articles can be flame-hardened in common machines, such as a lathe, if a suitable blowpipe is substituted for the ordinary tool. The major development work has been concerned with the design of oxyacetylene apparatus of sufficient ruggedness and flexibility to operate under rather severe operating conditions. It is necessary that such apparatus be water-cooled and of sufficient capacity to treat an area of reasonable size in one operation.

To insure uniform heating, a sufficient number of multiple-tip heads are necessary in several sizes. To accommodate various widths as well as irregular profiles, tips are preferably of the threaded removable type in various lengths. Plugs may be used so that only a portion of a large head can be operated if so desired.

In addition to all-purpose heads, it has been desirable to de-

FIG. 8 THIS HEATING HEAD FITTED WITH VARIABLE-LENGTH TIPS PERMITS THE FLAME HARDENING OF ROUND OBJECTS OR THOSE HAVING IRREGULAR PROFILES

sign heads for specialized applications such as gear-tooth hardening, crankshaft hardening, and the like.

For progressive hardening it is often convenient to mount the apparatus on one of the standard oxyacetylene cutting machines. It so happens that the desired speed falls within the range of speeds obtainable with cutting machines and they thus become ideal traversing devices.

Quenching. Quenching arrangements are affixed to the heating head for progressive or combination hardening. This insures a fixed relation between heating and quenching. Many devices may be used ranging from a simple stream of water from a round nozzle to a carefully designed spray nozzle. Spinning operations are better controlled by quenching with a large volume of water under low head which simulates total immersion.

Certain steels are too sensitive to be quenched with water. It has been found that a milder quench is obtainable by using soap-water solutions or a soluble cutting oil in water. If machine tools are used for flame hardening, the cutting-oil systems can be used for quenching. Several steels respond to air quenching and such arrangements are easily provided.

Stress Relieving. It has been recommended that flame hardening should be immediately followed by a low-temperature draw to relieve quenching stresses. This need not exceed 400 F, and can conveniently be done in an oil bath or oven. Few users of the process have followed this recommendation, and because service results have been uniformly good, further research may show that this recommendation is unnecessary in the great majority of cases. By carefully controlling the quantity and application of the quenching medium, or delaying its application, the treatment may be made self-drawing. Obviously, this technique is rather delicate if precise results are specified, but a proper balance of heat and quench can be established and maintained on a production basis.

COSTS AND APPLICATIONS

For general estimating purposes, 1 cu ft each of oxygen and acetylene will harden 4 sq in. of surface. Shop figures have been presented as high as 8 sq in. per cu ft of each gas and it is believed that the figure of 4 sq in. will be found quite conservative. Labor is difficult to estimate because so much depends on the surfaces to be treated. For assistance in estimating, the usual speed in progressive flame hardening is from 6 to 8 in. per min, and in roll or shaft hardening from 3 to 6 in. per min. Spinning operations are seldom longer than a 1-min heating period.

A complete list of the articles or parts that have been flame-hardened would be too long to be included here. The following articles have been selected more with regard to suggesting possible applications than to their general interest. Only a few can be included, and the naming of the part will in itself convey the areas which were treated:

Machine-tool ways	Sprockets, sheaves, and crane wheels
Cams and cam surfaces	Wobbler pads, coupler boxes, and mill turndown screws
Crankshafts	Piston rods, sucker rods, pump plungers
Power-shovel roller-path rings and track	Wrench jaws
Car-axle bearings and journal guides	Tractor shoes
Rail ends and rails	Internal area of cylinders
Valve stems, seats, and plugs	Internal area of relatively small holes for bearings
Oil-well-tool joints	
Pulp knives and hog knives	

SUMMATION

In closing, the several inherent as well as important advantages of the flame-hardening process seem worthy of summation:

(1) The equipment is ready for use instantly.

(2) Simple straight-carbon or inexpensive low-alloy steels can be used.

(3) The operation is rapid.

(4) Hardening is confined to the surface and can be done exactly where desired.

(5) Core properties are retained.

(6) The case depth can be varied easily.

(7) The degree of hardness can be varied.

(8) The size of the article is not a limiting factor.

(9) The quality is uniform.

(10) The tendency to distort is greatly minimized.

(11) A relatively small number of pieces are tied up in the hardening department.

(12) The equipment is truly portable.

(13) The process can be applied to a large list of steels, cast iron, malleable iron, and carburized parts.

(14) The equipment used for flame hardening can also be used for flame softening.

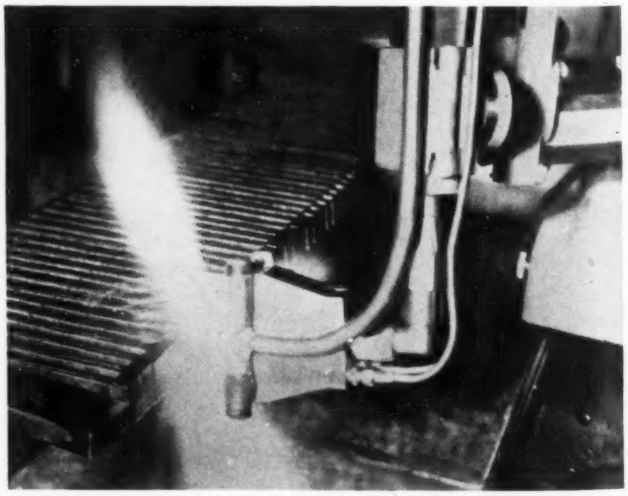


FIG. 9 PRODUCTION HARDENING PIPE WRENCHES WITH A 30-FLAME HEATING HEAD

(The water nozzle is attached directly to the head.)

OIL-PAD BEARINGS *and* DRIVING GEARS *of* 200-IN. TELESCOPE

By M. B. KARELITZ

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A MODERN large telescope is a complicated instrument weighing many tons. It must be mounted so that it can be pointed, with the minimum effort, toward any point of the celestial hemisphere, and it must be moved automatically and continuously so as to follow the apparent motion of the stars, due to the rotation of the earth. The star image must remain stationary on the photographic plate, or the slit of the spectrograph, for the entire period of exposure, which may be for several hours.

Thus, apart from the perfect optical system required, a telescope must possess a rigid structure to support this optical system and be driven in the two coordinates defining the position of the star at a uniform rate. As aptly described by Capt. C. S. McDowell, U. S. N. (Retired), in previous publications,[1] the optical system of the 200-in. telescope is carried on a tube which, in turn, is supported on its declination axis on the yoke or mounting. This yoke forms the polar axis of the telescope, about which it rotates in right ascension.

The entire weight of the telescope, approximately 1,000,000 lb, is carried on its north and south polar bearings which are arranged at their respective ends of the yoke, Fig. 1. The majority of large telescopes utilize ball or roller bearings to carry the load or to define the position of the polar axis, while the telescope itself is floated on mercury. However, mercury flotation at the north end of the 200-in. telescope would be extremely cumbersome, due to the horseshoe-shaped journal of its north bearing. The shape of the horseshoe girder was dictated by the required rigidity of the structure. It permits rotation of 105 deg east or west of the meridian and allows the tube to point to 1 deg below the north celestial pole.

Distribution of loads on the main bearings of the telescope is shown on the diagram, Fig. 1. At the north pier, the radial load is 567,000 lb, while at the south pier the radial load is 328,500 lb, and the thrust load is 593,400 lb. The resultant force at the south bearing is 678,305 lb, acting at an angle of 61 deg with the polar axis. The estimated magnitude of the torque required to rotate the polar axis in right ascension, were it mounted on roller and ball bearings, is about 22,000 ft-lb. Torque of this magnitude would have caused excessive torsional deformation of the yoke and would have required considerable horsepower to drive the telescope.

The principle of floating the telescope on an oil film was resorted to as the best practical solution for supporting and moving the heavy load. This idea was originally suggested by Francis Hodgkinson, consulting engineer of the Westinghouse Electric & Manufacturing Company at South Philadelphia, Pa., and developed with full cooperation of the engineering organization of that company. The carefully machined journals of the bearings are supported on oil pads. Oil, under sufficient pressure, is forced continuously through orifices in the pads and forms a film that carries the load.

Since the rate of rotation of the telescope, while observing, is slow, one revolution per sidereal day corresponding to the linear velocity of 0.02 ips at the periphery of the horseshoe, the forcing of the oil through the bearing pads obeys the laws of viscous flow. Consequently, the coefficient of friction of the oil-pad bearings at slow speeds is low. The quantity of oil forced through the bearings is also relatively small. For viscous or laminar flow in the oil film, the average velocity of flow is proportional to the square of the clearance and the pressure drop per unit length and inversely proportional to the viscosity of the oil.

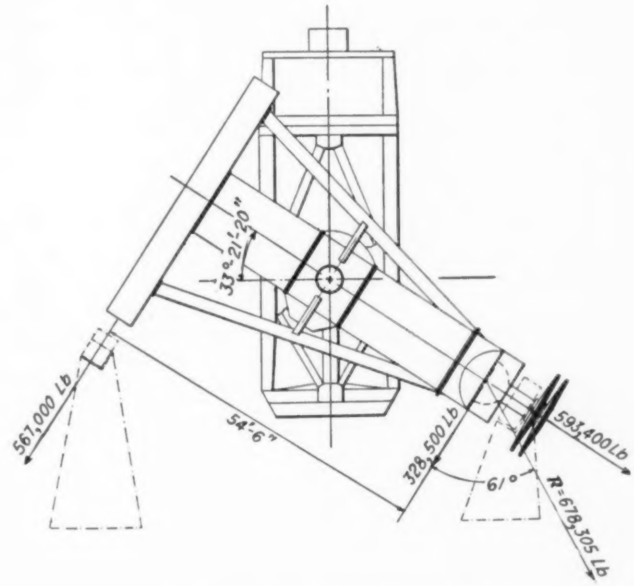


FIG. 1 200-IN. TELESCOPE BEARING LOADS

A circular oil pad is the simplest form for theoretical consideration. Assuming a pad of radius r_2 and having a recess of radius r_1, the average velocity W (in. per sec) at any radius r is

$$W = -(h^2/12\eta) \times (dp/dr)$$

Volume of oil Q flowing through the clearance in cubic inches per second is

$$Q = (\pi/6\eta) \times [h^3 p_p/\ln (r_2/r_1)]$$

where

h = clearance, in.
p_p = inlet pressure, lb per sq in.
η = oil viscosity, lb-sec per sq in.

It is seen that, at the same inlet pressure and oil viscosity employed, the quantity of flow will remain the same for oil pads of geometrically similar proportions.

To establish the quantity of oil flow, the lifting characteris-

Presented at the Spring Meeting, Los Angeles, Calif., March 23–25, 1938, of The American Society of Mechanical Engineers.

[1] "The 200-Inch Telescope," by Capt. C. S. McDowell, U. S. N., Mechanical Engineering, June, 1936, pp. 345–351; also "As the 200-Inch Telescope Develops," by Capt. C. S. McDowell, U. S. N., *Scientific American*, November, 1936, pp. 253–257; and "Building the 200-Inch Telescope," by Capt. C. S. McDowell, U. S. N., *Journal of The Franklin Institute*, December, 1937, pp. 675–695.

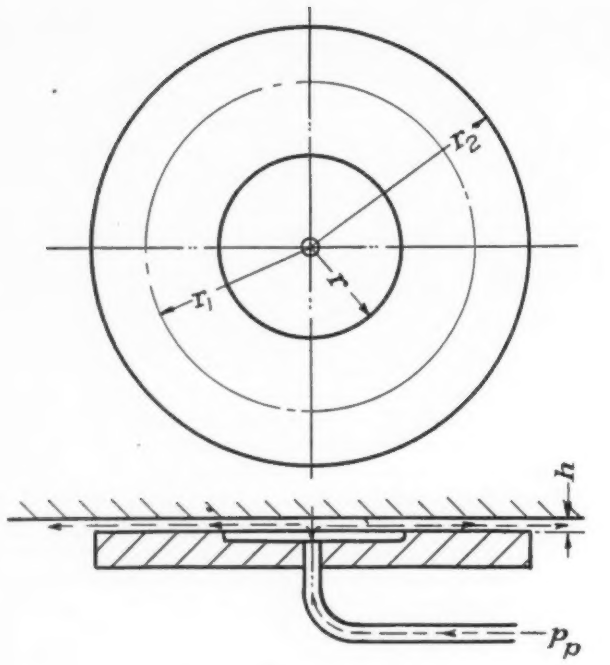
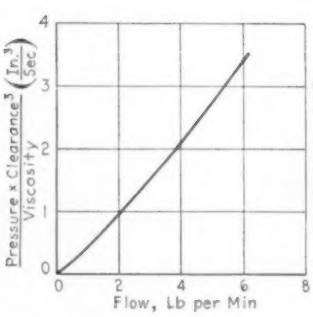


FIG. 2 CIRCULAR OIL PAD



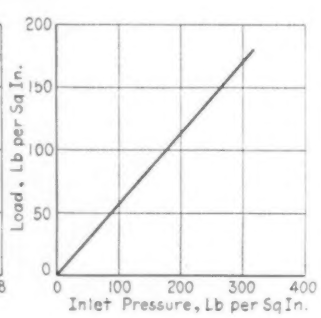


FIG. 3 OIL FLOW THROUGH 9 × 9-IN. OIL PAD

FIG. 4 LOAD-CARRYING CAPACITY OF 9 × 9-IN. SQUARE OIL PAD

tics, and the coefficient of friction of oil-pad bearings, a series of tests were performed by R. P. Kroon of the Westinghouse Company and Dr. Sinclair Smith of the astrophysical observatory of the California Institute of Technology. A 3 × 3-ft steel slab, 6 in. thick, loaded with lead bars, making a total weight of about 12,000 lb, was made to oscillate as a pendulum on an inclined plane formed by a main 9 × 9-in. pad and two small pads providing stability. The plane made by the three pads formed an angle of 5 deg with the horizontal. The pressure and quantity of flow through the pads were measured using SAE No. 10, SAE No. 30, and SAE No. 50 oils for different clearances. By making the pendulum swing and measuring the decrease of amplitude for successive cycles, it was possible to calculate the friction forces. From the results obtained, it was possible to estimate the coefficient of friction of the oil pads at the driving speed of the telescope to be about 2.6×10^{-6}. The quantity of oil flow through a square pad is shown in Fig. 3. By choosing the ordinate of the curve as shown, it is possible to reduce the results of many tests with different oils and clearances to a single curve.

It has also been established by test that the pressure necessary to lift a load after a standstill is from 20 to 30 per cent higher than the running pressure. The average pressure in the oil film sustaining the load over the total area of the pad was found to be about 56 per cent of the inlet pressure, independent of clearance (Fig. 4).

The energy in pound-inches per second generated in the pad and converted into heat is

$$E = p_p Q = (\pi/6\eta) \times [p_p^2 h^3/\ln (r_2/r_1)]$$

From consideration of heat losses in the pad, the following design recommendations can be made:

(1) To minimize the heat generated in the pad, it is important to make the clearance h as small as manufacturing tolerances permit.

(2) It is advantageous to use as large a pad as is permissible with respect to deformations of the bearing surface. A small number of large pads requires less power than a large number of small pads.

(3) To carry the same load, low pressure on a large area is better than high pressure on a small area, so far as the flow is concerned.

(4) The recesses should be small. However, they probably have to carry a major part of the load when starting, the oil film not being developed.

(5) It is advantageous to use highly viscous oil. Higher viscosity requires more power to drive the telescope, but, if viscous friction is assumed, this power would still be negligible.

The system of the oil-pad bearings was found to be stable and Mr. Kroon's analysis shows that this stability is maintained by the pressure drop in the orifices. The design of the telescope yoke bearings is based on these recommendations.

BEARING DESIGN AND LOADS

The journal of the north bearing is formed by the 30-in-wide track carefully machined on the periphery of the 46-ft diameter horseshoe-shaped box girder. The horseshoe is supported on two pairs of 28-in. square pads spaced 30 deg from the vertical center line (Fig. 5). The pads are supported on a hardened

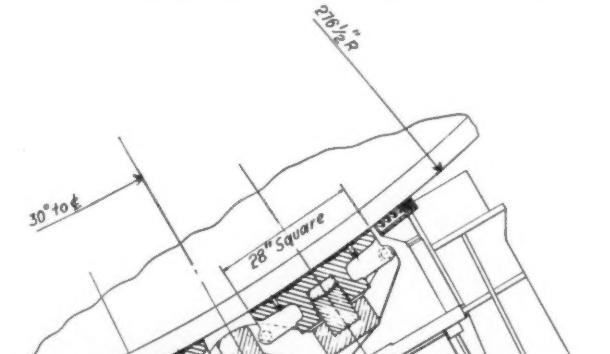


FIG. 5 SECTION THROUGH NORTH BEARING UNIT

spherical seat on an equalizer casting which, in its turn, is supported on a cylindrical seat on the north pedestal of the telescope. The babbitted surfaces of the pads are machined to match the curvature of the horseshoe track. In each pad are four 7 × 7-in. recesses. Oil from the constant-displacement high-pressure pump is supplied to these recesses through controlled orifices. The pads are self-aligning, but hardened buttons are provided to prevent their rotation on the spherical seats. Since the polar axis of the telescope forms an angle of 33 deg, 21 min, 20 sec with the horizontal and the bearing pedestal is set at the corresponding angle from the vertical, the tendency of the bearing units to slide downhill is eliminated by counterbalancing the lateral component of their weight with springs.

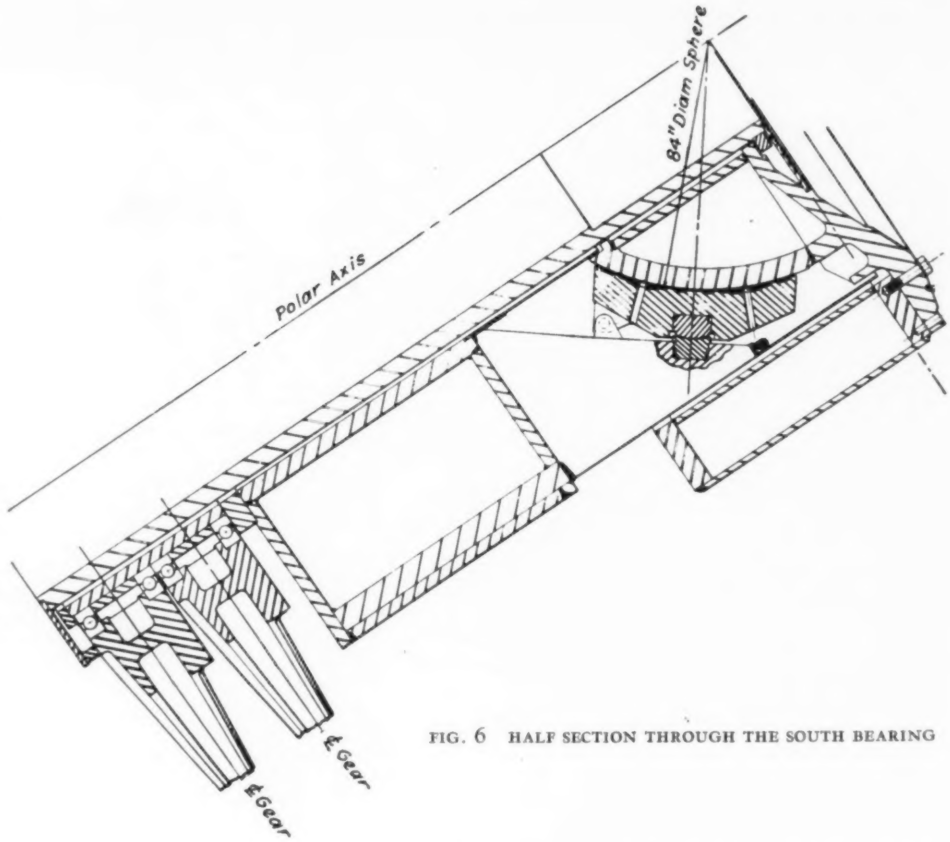


FIG. 6 HALF SECTION THROUGH THE SOUTH BEARING

The south bearing, Fig. 6, consists of an 84-in. diameter spherical cup located in the south cross member of the yoke and connected to it by a heavy flange. This spherical cup, forming the journal of the bearing, is supported from the south pier on three self-aligning pads carrying both the radial and thrust load of the telescope. These pads carry equal normal loads and are similar in construction to those already described, though larger in size. In plan, they are formed from a square, the side of which is $30^1/_2$ in. and the corners of which are removed on a 40-in. diameter circle to obtain greater clearance for accessibility. Reactions of these loads, intersecting at the center of the sphere, form a tripod supporting the weight of the telescope.

It is expected that the bearing parts will be machined well within 0.005-in. tolerance. Variation of the thickness of the oil film over a comparatively small angle subtended by the pads, therefore, will be small, and it is expected that this thickness will be maintained between 0.003 and 0.005 in.

Projected areas of each pad at the north and south bearings are 784 and 1144 sq in., respectively. The loads that they carry are about 115,000 and 330,000 lb each, corresponding to average and inlet pressures of 210 and 375 lb per sq in., respectively, for the north-bearing and 290 and 518 lb per sq in. for the south-bearing pads. Separate constant-displacement oil pumps will be used for the north and south bearings. Assuming that SAE 30 grade oil is used and 0.005 in. thickness of oil film, the required delivery of these high-pressure pumps is 2.75 lb per min per pad at the north bearing and 3.6 lb per min per pad at the south bearing, or a total of about 1.5 gpm for each pump. Flexible pipe connections to the orifices in the pads are required to allow their freedom of movement. To compensate for variation in delivered pressure due to losses in individual lines, each orifice is separately controlled by a needle valve.

The south bearing is enclosed, thus the problem of sealing it or making it dustproof is not difficult. At the north end, however, the 46-in. diameter journal of the bearing is exposed to the atmosphere. It becomes necessary to remove all oil and wipe the surface of the journal after it passes the oil-pad units, wherefore, a series of spring scrapers is introduced at the edges of the bearing housings. An additional leather seal makes these units dustproof. To a certain extent, these seals will increase the bearing friction, and it is difficult to predict the exact amount of torque that will be required to move the telescope in right ascension.

Power required to drive the telescope at the sidereal rate of one revolution per day is small and the $^1/_{12}$-hp clock motor to be used is considerably in excess of the requirements. At the setting speed, which is 180 times greater than the normal rate, the torque required to drive the telescope is proportionately increased. A 3-hp motor is provided for setting the telescope into position.

However rigid the horseshoe girder is, it will deflect, and the ends of the horseshoe will close in a certain distance as it rotates about the polar axis. This deflection has been calculated and checked by a model test. To offset the error introduced by the deflection, the horseshoe track is being machined in stressed condition so that the divergence of the track from a true circle and deflections of the horseshoe, due to load at its different positions, will largely cancel each other.

GEARS DRIVING TELESCOPE ARE EXTREMELY ACCURATE

The desired accuracy of the right-ascension drive is 1 sec of arc in 1 hr of time, the driving speed of the telescope being one revolution per day. Besides, the maximum allowable amplitude of a periodic error of the drive is 0.1 sec of arc in 5 sec of time. Similar accuracy is desirable for the declination drive. Requirements of this nature call for driving gears of extreme precision. One 173-in. OD, 720-tooth, 0.750 circular pitch, 3.25-in. face worm gear, attached directly to the telescope tube, is employed to drive the telescope in declination. Two gears of the same dimensions, supported on bearings from the south

pier, drive the telescope in right ascension through a torque tube. The north end of the torque tube is connected, by a flexible diaphragm, to the spherical cup of the south bearing. The south end of this torque tube is similarly connected to the lower right-ascension gear used to set the telescope into the desired position by a motor and a suitable reduction, at a speed of $1/8$ rpm, while the accurate gear is floating on its bearings. When the telescope is focused on a star, the accurate upper right-ascension gear is clutched to the "fast" gear, the thrust of the "fast" worm being simultaneously released, and the telescope, driven by the worm connected to the sidereal clock mechanism, continues to follow the star. Three worms that drive these gears are 7.25-in. OD, single thread, 6.500 in. normal pitch diameter. The included angle of the tooth is 20 deg and its

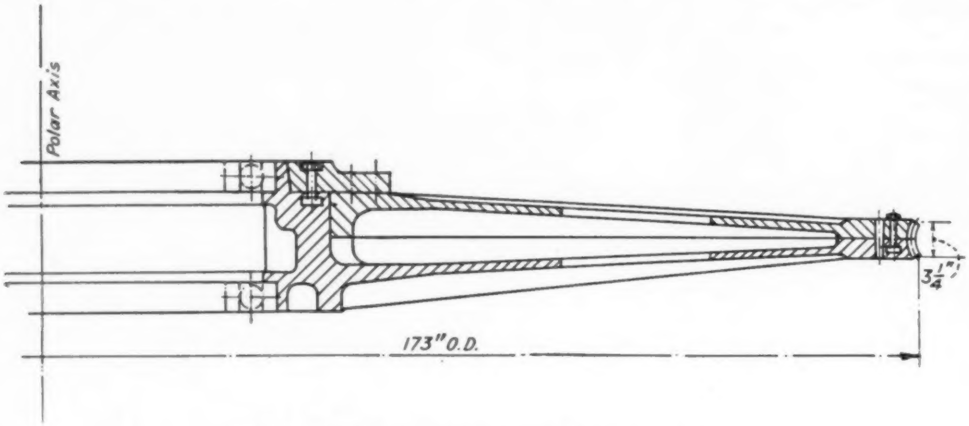


FIG. 7 HALF SECTION THROUGH THE DRIVING GEAR

depth is 0.825 in. The center distance of the worm and gear is 89 in.

Worm and worm-wheel drives have been selected to impart rotation to the telescope in right ascension and declination, as their manufacture lends itself to greater precision. Also, the errors in worm-wheel tooth spacing can be minimized. The importance of the precise tooth spacing becomes evident when it is realized that 1 sec of arc on the pitch circle of the 173-in. OD gear is only 0.0004 in.

Proper material for a precision gear should possess good machining and lapping qualities. It should have good resistance to wear, maintain its shape, and be free from distortions due to aging. As the result of a series of stress-relieving tests carried out on various cast irons, 0.5 per cent molybdenum cast iron, stress relieved at 1200 F before and after rough machining, was selected as the most suitable material for the gear. Oil-hardening steel, heat-treated to accelerate aging, is being used to produce the ground drive worms.

The split-wheel principle employed in cutting the 200-in. telescope worm gear is not new though it is not widely known. In 1936, two small precision gears of 11.28 in. pitch diameter employing the split-gear lapping method were produced in the physics department of the California Institute of Technology for an X-ray spectrometer, under the direction of Dr. Jesse W. M. DuMond. In this work, Dr. DuMond has, for the first time, to our knowledge, recognized the great importance of adhering rigidly to a certain schedule of displacements of the two halves of the split worm wheel, relative to each other, between stages of lapping. As he shows in a paper[2] describing his spectrometer, the appropriate displacements expressed in terms of fractions of one revolution should be $(1/2)^n$, where n is an integer that takes successive values of 1, 2, 3, and so on. This work was largely responsible for the adoption of this method for the manufacture of the large telescope gears. A full description of this work, and its underlying theory, is given in the article.

The gear is split into halves in a plane perpendicular to its axis of rotation (Fig. 7). The halves of the gear blank fit together on carefully scraped conical and plane surfaces, the cone being made concentric with the axis of rotation and the outside diameter of the gear rim. The two halves of the gear are held together by 16 taper dowel pins and two rows of bolts fitting in T-slots machined in one of the castings.

Since teeth are cut in each half of the gear, spacing of the taper dowels must be accurate to permit a good match of all teeth, when the two gear halves are held together, irrespective of their relative circumferential shift of $1/16$ revolution or its multiple. This is accomplished by successive rotation of the two halves of the gear blank through $1/2$, $1/4$, $1/8$, and $1/16$ of a revolution and reaming the taper pin holes each time to the minimum depth to allow the pin to enter in all 16 holes.

Indexing of the gear teeth, while gashing them, is done from a set of $1/2$-in. diameter toolmakers' buttons, accurately spaced in a groove on the periphery of a dividing plate. This plate is of about the same diameter as the gear and rests on the top of it, the button groove being concentric with the pitch circle.

Due to the possibility of slight inaccuracies in indexing, and the nonhomogeneity of cast iron, a small inequality of tooth spacing, after hobbing, may be expected. The method of eliminating or distributing these errors is to shift the two halves of the gear circumferentially with respect to each other through $1/2$, $1/4$, $1/8$, or $1/16$, of a revolution between successive stages of hobbing or lapping. With 720 teeth and 16 equally spaced taper pins, it is possible to shift the two halves of the gear through 180, 90, 45, and $22^1/_2$ deg. After each successive shift, during hobbing or lapping of the gear, individual errors in tooth spacing are distributed around the circumference of the gear. The number of errors is doubled, but their magnitude is cut in half. After the final shift possible on taper pins and lapping, a periodic error of small amplitude may still be discovered. This error can be successfully reduced by an additional lapping after shifting one half of the gear through a computed number of teeth and securing it to the other half by bolts only, for which T-slots in the lower half of the gear are provided.

The tube, mounting, and bearing parts of the 200-in. telescope are being manufactured at present at the South Philadelphia plant of the Westinghouse Electric & Manufacturing Company. The large gears are cast, stress relieved, and rough machined by this company; the finish-machining, fitting, and cutting of the gears is being done in the astrophysics instrument shop of the California Institute of Technology.

In preparation of this paper, the author is indebted to the personnel of the astrophysics department of the California Institute of Technology and of the Westinghouse Electric & Manufacturing Company taking part in the work.

[2] "A Precision Two Crystal X-Ray Spectrometer of Wide Applicability With Worm Wheel Drive; an Improved Precise Method of Equalizing the Spacing of Worm Wheel Teeth," by J. W. M. DuMond and Douglas Marlow, *Review of Scientific Instruments*, April, 1937, pp. 112–121.

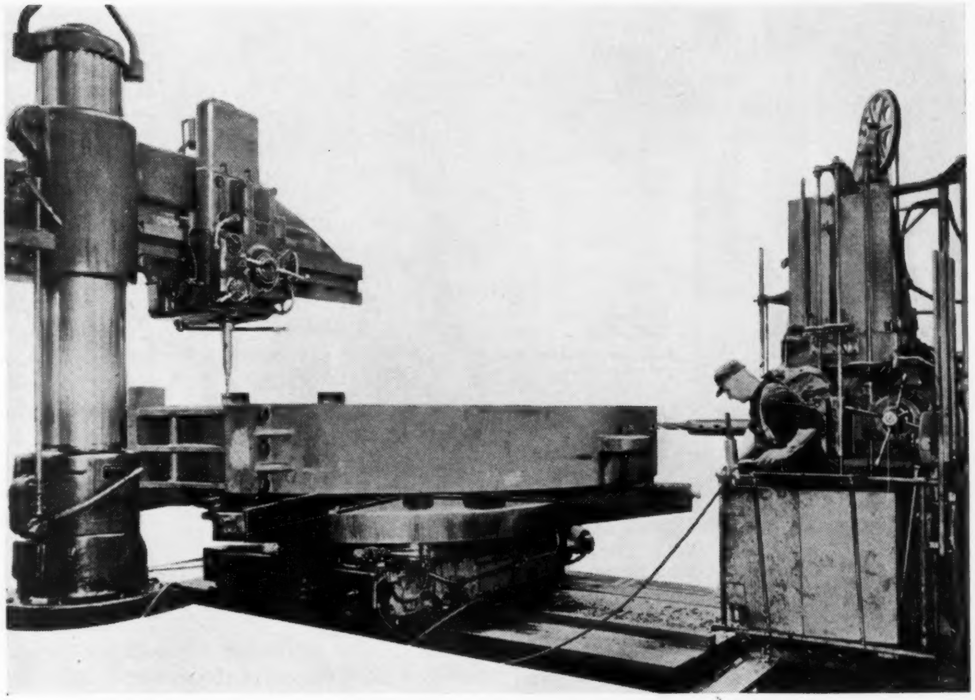


FIG. 1 COMBINATION OF HORIZONTAL BORING, DRILLING, AND MILLING MACHINE WITH A PORTABLE RADIAL DRILLING MACHINE FOR DRILLING RADIAL, TRANSVERSE, AND VERTICAL HOLES AT A SINGLE SETUP

Trends in SHOP PRACTICE *and* DRAFTING

By W. L. BOND

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An outstanding general trend in mechanical design in the last 30 years has been toward demands, at a constantly increasing rate, for closer accuracy in the machine shop and toolroom. However, in the same period there have been but few general changes in ordinary drafting practice to help the shop to meet these demands. As a result, a notable increase has occurred in the amount of mathematical calculation that must be made to reduce mechanical designs to practice. The object of this paper is to point out a few fundamental principles, which, if applied to drafting practice, will bring the latter more nearly in line with shop practice and be of mutual benefit to both arts.

Three linear movements and one angular movement are commonly used on machine tools to position the cutting tool with respect to the workpiece before a given machining operation is started. The direction of each of the three linear movements, longitudinal, transverse, and vertical, is perpendicular to each of the other two. Where linear movements only are used, the length of a line connecting any two positions of the cutting tool is determined by its projected length on three planes, each of which is perpendicular to one of the linear movements. Such base planes, real or imaginary, are established on the workpiece from which to measure relative positions of the cutting tool. These same planes are used for each operation performed during a given setup and, whenever practicable, in additional setups, thus preventing accumulation of errors.

The angular movement in common use is one of rotation about an axis that is fixed in a direction perpendicular, or parallel, to one of the three linear movements. It is used to locate the cutting tool in axial positions about a fixed center line in the workpiece. The axial position of the cutting tool at the start of each operation is measured from a base plane, which is determined by the axis and some other straight line selected in accordance with the work to be done. Angles are inherently difficult to measure accurately, and, for this reason, the angular movement for positioning the cutting tool is avoided wherever it is practicable to do so.

The following machine tools were selected to illustrate the principles previously outlined and, at the same time, to indicate some of the progress made toward the increased use of machine tools equipped to lay out, as well as machine, a piece of work, with the minimum of scribed lines and center-punched points, where the quantities do not justify special jigs or fixtures. The jig borer, designed to lay out, drill, and bore holes that are accurately spaced from each other and from other surfaces, is today, perhaps, the most widely used of all machine tools equipped to lay out and machine work to precision limits. In practice, the centers of all holes having parallel axes, which do not lie on a circle, are preferably located from two base lines lying in a plane perpendicular to the axes of the holes and to each other. Circles of equally spaced holes with parallel axes and radial holes are located by rotating the work about a fixed axis.

Fig. 1 shows a horizontal boring, drilling, and milling machine equipped with a revolving table and combined with a portable radial drilling machine. With this equipment, it is necessary to lay out only one of a series of either radial, transverse, or vertical holes, after which the operator can locate and

Presented at a meeting of the Machine Shop Practice Division, Rochester, N. Y., May 10-12, 1938, of The American Society of Mechanical Engineers.

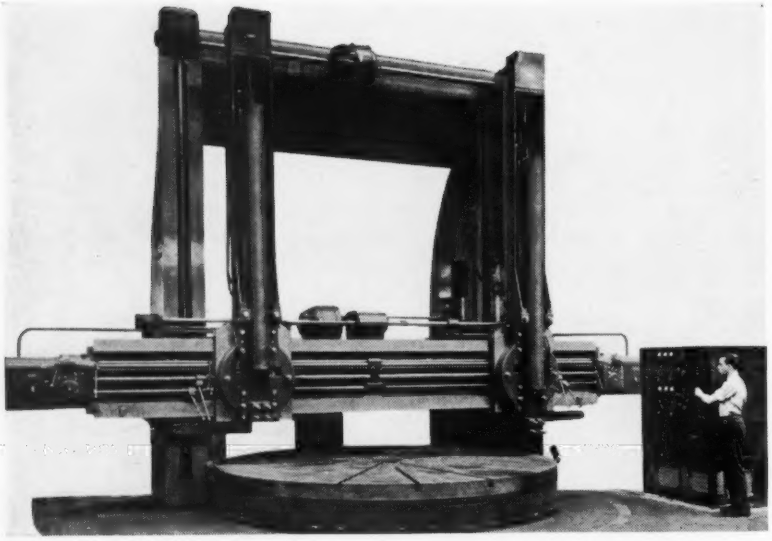


FIG. 2 A 14-FT FLAT-BASE BORING MILL EQUIPPED WITH PRECISION DIAL CONTROLS

drill the rest of the holes in the series without further layout and without leaving the operating position. For convenient setup of the workpiece, the revolving table is equipped with a set of jaws, graduated and operated independently of one another. A circular, adjustable scale on the base of the table is graduated in half degrees and divided into convenient groups of equal spaces to suit requirements. With the aid of a telescope and a periscope, these graduations are visible from the operating platform of the larger machine. Adjustable scales indicate the longitudinal and vertical movements of the boring head. The radial drilling machine is also equipped with adjustable scales to indicate relative movements of the drilling head. All movements of both machines are controlled by electric push buttons with suitable speed ranges. The workpiece shown is set up for drilling 94 transverse and radial holes from 1 to 17 in. in depth and $^3/_4$ to $1^7/_8$ in. in diameter and 51 vertical holes from 1 to 3 in. in depth and $^1/_2$ to 2 in. in diameter.

Fig. 2 shows a flat-base 14-ft vertical boring mill especially equipped to machine, to close limits, plane and cylindrical surfaces with the minimum amount of layout. This is accomplished by precision automatic control of both the longitudinal and vertical movements of the cutting tool, each of which is predetermined by the setting of three adjustable dial indicators graduated in feet, inches, and thousandths of an inch, respectively. To machine the surfaces indicated by the heavy lines on the casting shown in section in Fig. 3, the top plane and the top bored surface are first established as bases, and the location of each is indicated on the adjustable dials as 0. With these bases as references, the depth and diameter of each bore is determined by dial settings without the necessity of any further layout.

It is hoped that the following details in connection with this machine and its control equipment will be of enough interest to excuse a brief digression here. Concentricity of the table is assured by two precision preloaded center ball bearings, as recently developed by the builders. Longitudinal and vertical movements of the cutting tool are each controlled by a set of two screws, the operating or load-carrying screw and a "positioning" screw that carries little load. The operating screw guides the saddle or ram and is governed by the positioning screw which is geared to it by antibacklash spur gears. Movement of each positioning screw is, in turn, controlled electrically by the setting of the corresponding three indicating dials mentioned in the preceding paragraph. Each of the two positioning screws is 13 ft long, with a pitch diameter of $2^1/_2$ in. and a lead of 5 threads per inch. The accumulated lead error in the total length of each screw is so small as to be difficult to measure. This degree of accuracy was obtained by the use of a lathe that was especially equipped for the purpose. Features of this lathe include a carefully prepared bar fed by hardened and ground friction rolls that replace the conventional lead screw and feed nut. The threading-tool support is carefully counterweighted so that the friction rolls have to overcome the resistance of the cut only.

The milling planer, illustrated in Fig. 4, is well equipped to reduce layout and calculation on many classes of work. In addition to the arrangements for both milling and planing, provision can be made for the convenient location and machining of holes, cross slots, or keyways to precision dimensions. This is accomplished by micrometer adjustment of three linear movements of the cutting tool with respect to the work.

A good example of the trend toward easy setup and away from point-and-line layout is the turret punch shown in Fig. 5. This equipment locates and punches, one at a time, holes and louvers in sheet-steel control panels that have been previously sheared to size. The press is of 75 tons capacity and has a 54-in. throat. The turret contains 32 quick-change die sets, each of which can be power-indexed to the single working center by push-button control. The table has hand-operated transverse and longitudinal movements, and is of a size to position any part of a sheet 50 × 100 in. at the single working center.

In practice the sheet is located and clamped on the table with respect to two straight perpendicular reference lines corresponding to the transverse and longitudinal movements, which are designated X and Y, respectively. The operator is furnished with a "punch sheet" that contains the punch number and the X and Y location of each hole or louver to be punched. The turret is indexed to bring the center of the desired die set into the single working position. The table is moved to bring the sheet into the proper X and Y position, indicated by transverse

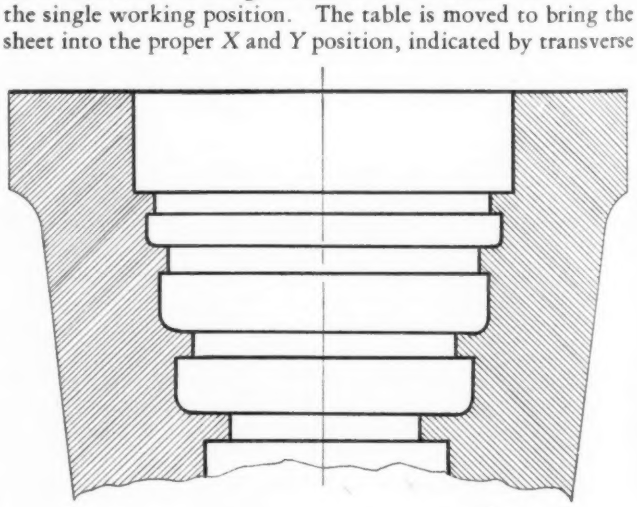


FIG. 3 TYPICAL EXAMPLE OF WORK DONE ON THE BORING MILL SHOWN IN FIG. 2

and longitudinal scales, and the press is tripped.

The principles of accurate measurement as previously outlined and illustrated have been in general use by toolmakers, machinists, patternmakers, and inspectors, especially in industries so organized that dies, jigs, gages, and the like for interchangeable parts can be designed and made under separate supervision. The same principles have been successfully applied to mechanical designs and adopted as standard drafting practice by a number of organizations, especially by organizations making tools and instruments.

It is common drafting practice to shift from one base line to another and to shift back and forth between linear and angular dimensions. This latter may well be compared to a shift back and forth between centimeters and inches. The confusion that may result from an impracticable use of angular dimensions becomes evident if an attempt is made to express tolerances in minutes and seconds for angular dimensions as used on many design drawings. It is also common drafting practice to indicate a contour radius without giving the location of its center, although such locations are frequently necessary in the shop. The bulk of the mathematical calculations that must be made to reduce mechanical designs to practice consists in reducing the number of base lines to a workable quantity, substituting linear dimensions for angular, and locating the centers of contour radii that must be drilled or bored.

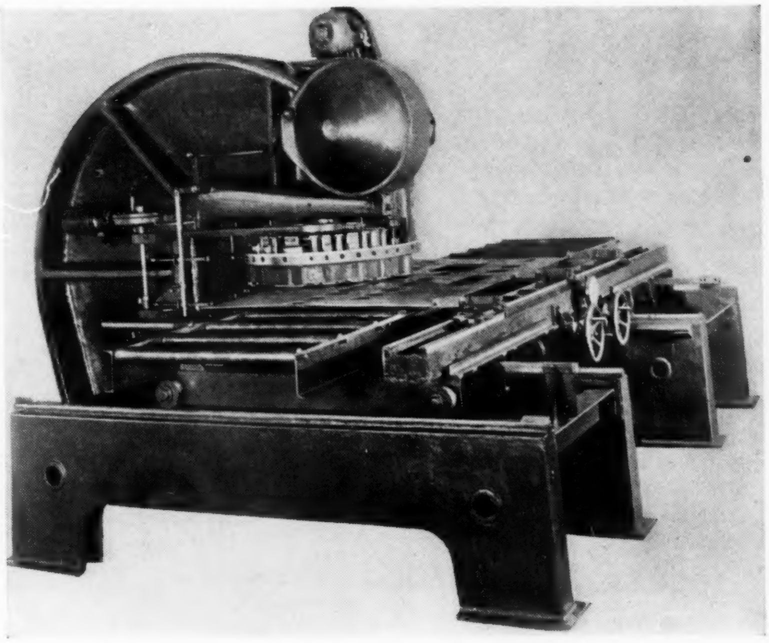


FIG. 5 TURRET PUNCH FOR LAYING OUT AND PUNCHING SHEET METAL

In many cases, these calculations, which frequently are complicated, must be repeated by different men, such as the patternmaker, modelmaker, tool designer, tool inspector, gage designer, gage inspector, machinist, or product inspector, several of whom may be responsible for working to the same drawing. Where tools, gages, or individual parts are later duplicated, it may be necessary for several men to repeat the same calculations. These men are not always adept mathematicians. Furthermore, while they are engaged in solving geometric and trigonometric problems, valuable equipment may be lying idle.

Many of these calculations can be made once and for all by the draftsman, who is more adept at mathematics, or entirely eliminated by him, resulting in a substantial reduction in net engineering and manufacturing costs. The draftsman can accomplish this if he will dimension drawings in accordance with shop practice, or, when this is not practicable, furnish supplementary drawings so dimensioned, which will establish permanent records for the common reference of patternmakers, modelmakers, tool and gage designers, inspectors, and the like, and thus avoid costly duplications of effort on their parts and possible mistakes and misunderstandings. These men must be sure of their figures, since a single mistake will almost certainly result in a misfit of mating parts or otherwise cause a substantial loss. A minor dimensional mistake made by the draftsman, however, may not necessarily result in a misfit of mating parts or cause any damage to the product, since the same mistake will appear in all related parts.

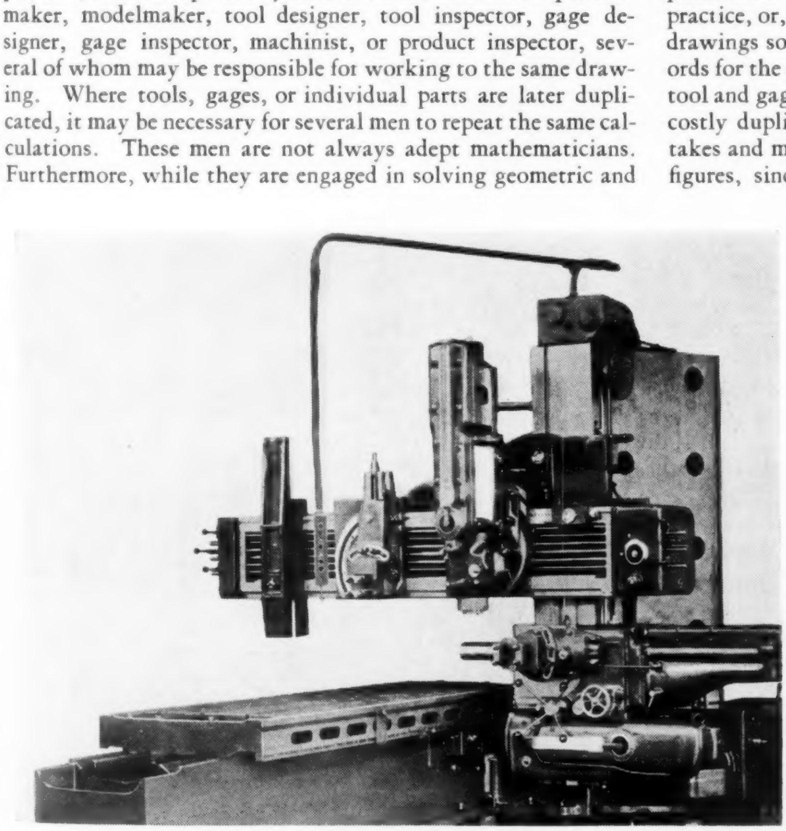


FIG. 4 MILLING PLANER WITH SPECIAL EQUIPMENT FOR MACHINING HOLES, CROSS SLOTS, OR KEYWAYS TO PRECISION LIMITS

Fig. 6 illustrates a type of calculation that is frequently necessary and was selected as typical from a folder full of similar sketches and calculations made by a shopman. Angular dimensions shown in light lines were copied from the drawing. The linear dimensions shown in heavy lines were those required by the shop. No records are available to show the number of times that this was repeated, but, from the nature of the product, it may be safely stated that these same calculations were repeated by at least eight men, who may or may not have used more rapid methods. A design drawing, supplementary drawing, or layout, dimensioned in accordance with shop practice could have been made by the draftsman for a fraction of the cost of making and repeating these calculations.

Experience has proved that, when a designer assumes the responsibility of making drawings in accordance with shop practice, he can

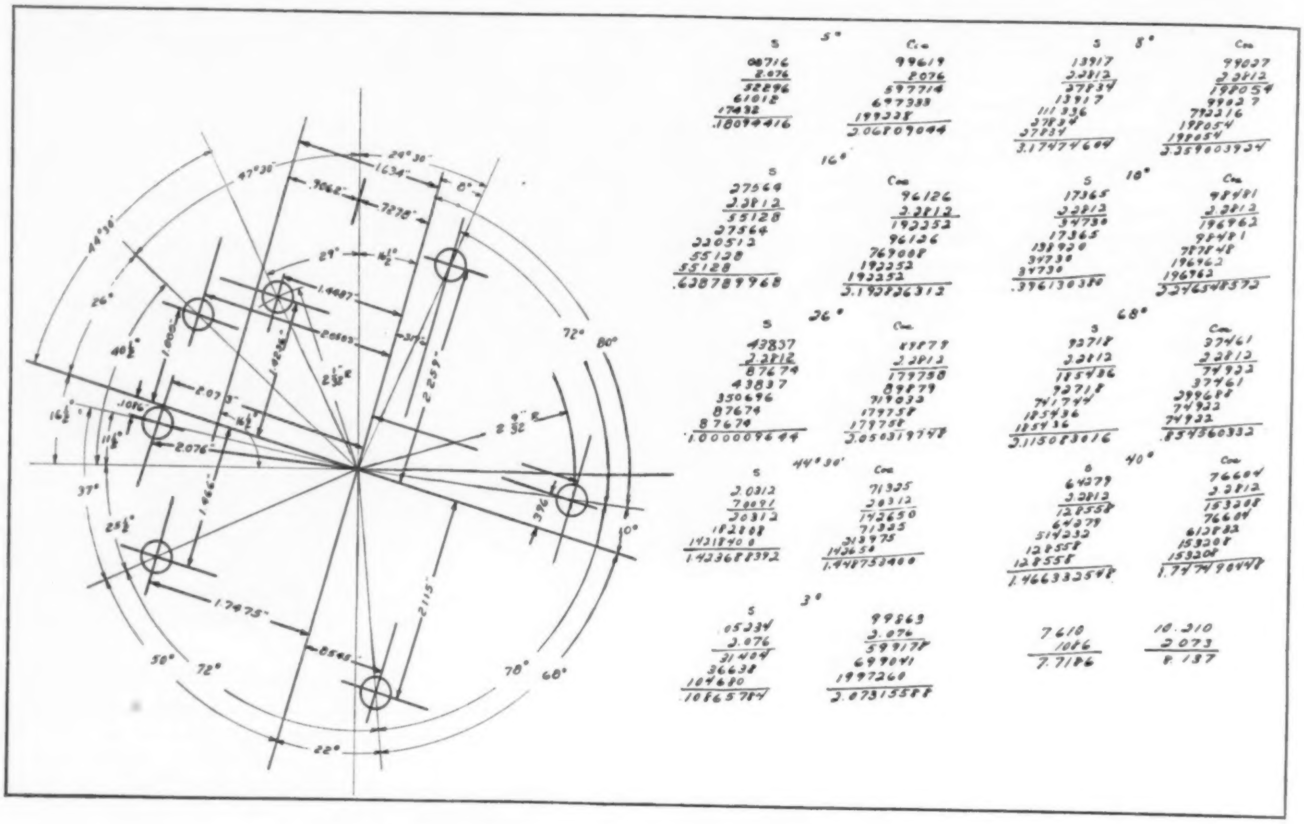


FIG. 6 EXAMPLE OF CALCULATIONS THAT ARE MADE IN THE SHOP

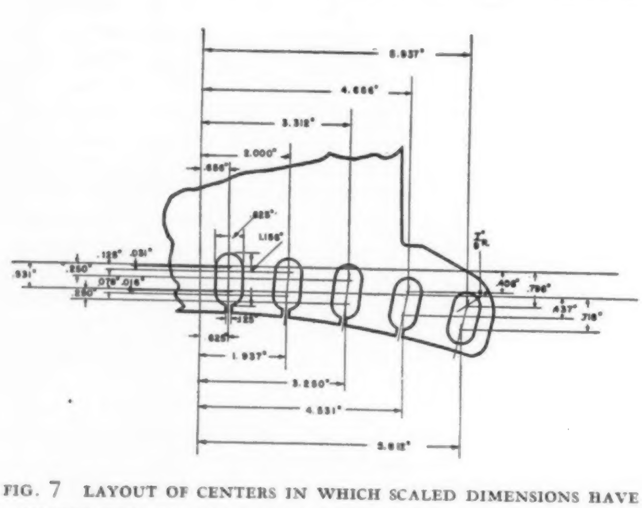
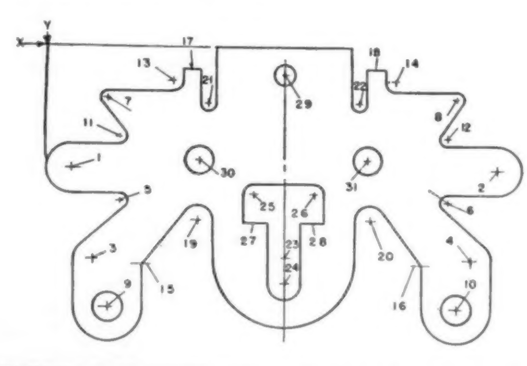


FIG. 7 LAYOUT OF CENTERS IN WHICH SCALED DIMENSIONS HAVE REPLACED THOSE THAT WERE FORMERLY CALCULATED IN THE SHOP

successfully scale many dimensions which would otherwise have to be calculated. The layout of centers, as shown in Fig. 7, was taken from a design drawing. The linear dimensions were scaled by the draftsman on a normal layout after they had been located by the intersections of arcs. The latter method was formerly standard and caused the tool designer, inspector, and others to calculate the linear dimensions now scaled by the draftsman.

The style of dimensioning used in Fig. 7 is not always practicable when a large number of working points are included in a small space, since the dimension lines may be too close to be readily followed. In such cases, dimension lines may sometimes be omitted to good advantage and entered on a chart as shown



NO.	CONTOUR RADII	HOLE DIA.	Y	X
1	$\frac{5}{16}$"		.772"	.1 56"
2	$\frac{5}{16}$"		.772"	2.794
3	$\frac{1}{8}$"		1.336"	.582"
4	$\frac{1}{8}$"		1.336"	2.647"
5	$\frac{3}{64}$"		.976"	.459"
6	$\frac{3}{64}$"		.976"	2.491"
7	$\frac{3}{64}$"		.209"	.459"
8	$\frac{3}{64}$"		.209"	2.491"
9	$\frac{7}{32}$"	.199"	1.639"	.350"
10	$\frac{7}{32}$"	.199"	1.639"	2.553"
11	$\frac{3}{64}$"		.359"	350"
12	$\frac{3}{64}$"		.359"	2.553"
13	$\frac{1}{16}$"		.209"	.787"
14	$\frac{1}{16}$"		.209"	2.163"
15			1.336"	0
16			1.336"	0

NO	CONTOUR RADII	HOLE DIA.	Y	X
17			.145"	0
18			.145"	0
19	$\frac{3}{32}$"		1.039"	.959"
20	$\frac{3}{32}$"		1.039"	1.991"
21	$\frac{3}{64}$"		.319"	1.006"
22	$\frac{3}{64}$"		.319"	1.913"
23	$\frac{7}{16}$"		1.326"	1.475"
24	102"		1.438"	1.475"
25	$\frac{1}{16}$"		.929"	1.288"
26	$\frac{1}{16}$"		.929"	1.662"
27			1.222"	0
28			1.222"	0
29		.159"	.173"	1.288"
30		.173"	.959"	.709"
31		.173"	.959"	1.975"

FIG. 8 DIMENSIONS CAN SOMETIMES BE EFFECTIVELY OMITTED FROM A DRAWING AND ENTERED ON A CHART

in Fig. 8. This supplementary drawing shows the flat development of a thin formed punching as it was prepared by the drafts

man for the convenience of the diemaker. It will be noted that the locations of all contour-radii centers are shown. Important dimensions were calculated, others were scaled with a vernier tram graduated in thousandths of an inch.

A typical design drawing of a part to be molded from a plastic compound is shown in Fig. 9. Base planes that coincide with important working surfaces were chosen for the convenience of the mold designer and inspector and also to improve the product. Centers of contour radii are omitted where the arcs are used merely to blend one surface with another. Fig. 10 is one view of a casting dimensioned in accordance with shop practice. Over-all base lines are maintained. However, certain base lines are shifted to effect greater accuracy between important details. Fig. 11 illustrates a practicable method for dimensioning a shaft, the base line being chosen with due regard for important working points.

Purposely, no hard and fast rules are offered to the draftsman here because the over-all effect of major changes in drafting practice must, of necessity, involve personal contacts and common understandings between designers and all users of the drawings. Primarily, this effort is merely to point out some specific possibilities that will lead to a greater use by the shop of drawing dimensions without additional calculations. In introducing any of the departures previously mentioned, it should always be borne in mind that real progress can best be made slowly.

It is a generally accepted fact that a college education is designed primarily as a training course in fundamental principles with few details. However, the reverse appears to be true of college courses dealing with shop practice. Details of shop practice appear to be stressed, and fundamental principles almost entirely omitted. It is suggested that some of the fundamental principles of shop practice as outlined in this paper could well be included in college courses covering mechanical design and mechanical drawing. This would result in mutual benefits to colleges, students, and metal-working industries.

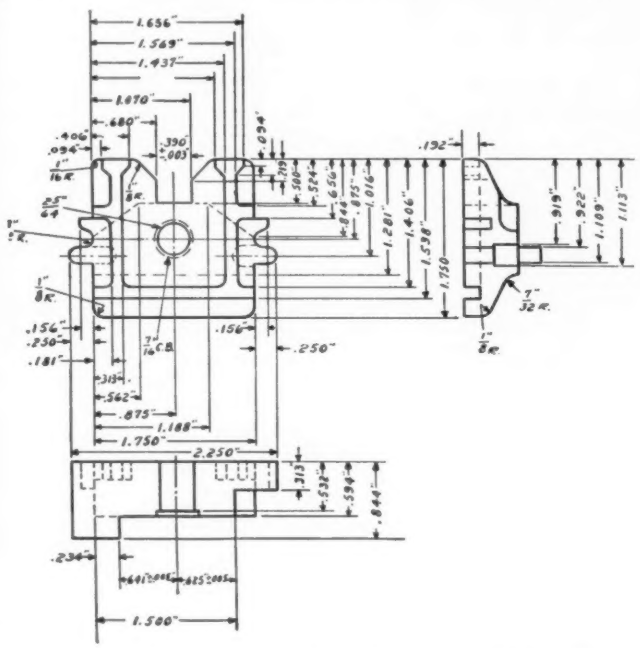


FIG. 9 DESIGN OF A PART TO BE MADE FROM A PLASTIC COMPOUND AND DIMENSIONED FOR THE CONVENIENCE OF THE MOLD DESIGNER AND THE INSPECTOR

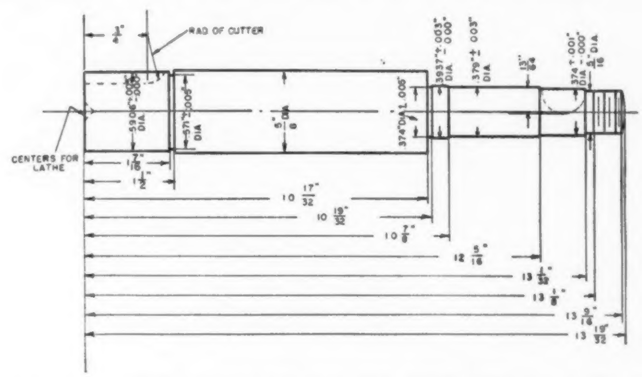


FIG. 11 A PRACTICABLE METHOD FOR DIMENSIONING A SHAFT

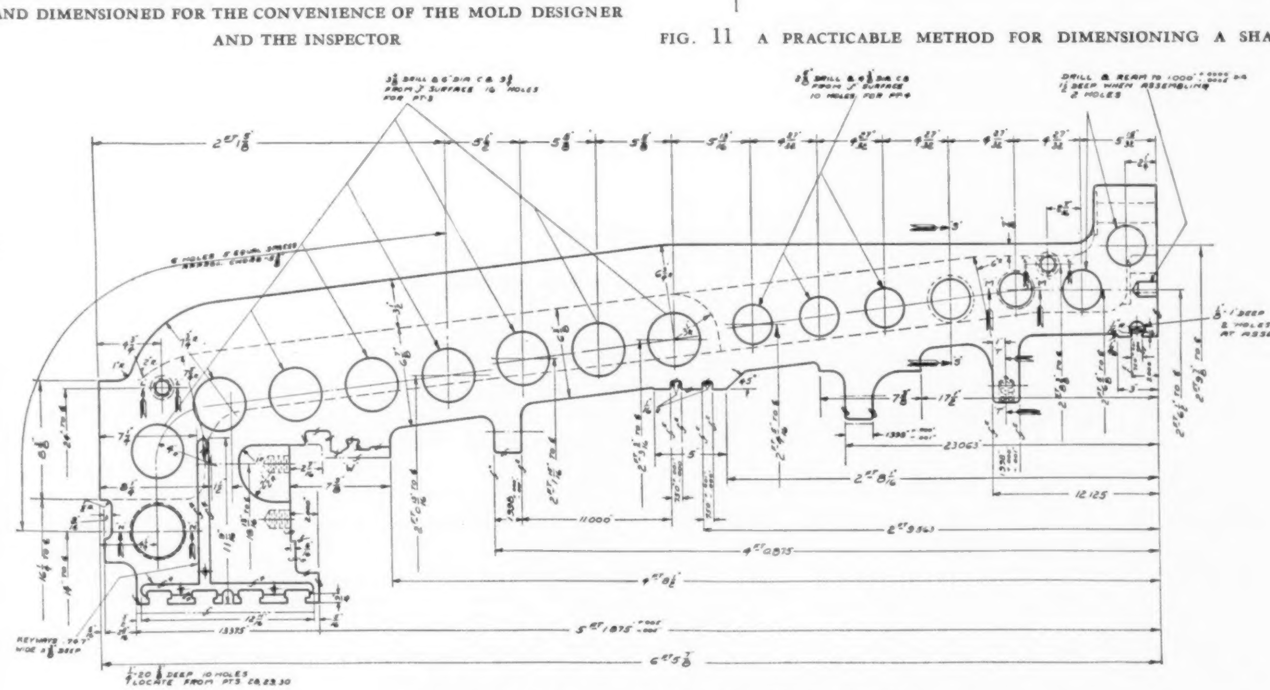


FIG. 10 ONE VIEW OF A WELL-DIMENSIONED CASTING
(Some of the base planes have been shifted to effect better accuracy between important details.)

The Rôle of the

ENGINEERING LIBRARY

What Should It Contain and How Should It Be Used?

By HARRISON W. CRAVER

DIRECTOR, ENGINEERING SOCIETIES LIBRARY, NEW YORK, N. Y.

LIBRARIES are universally recognized as essential to modern civilization. In a world that gets most of its learning through the printed word, storehouses of print are a vital necessity. In this regard engineering differs in no way from the other learned professions. Whenever we wish to extend our knowledge beyond our immediate environment, we turn directly to a library. Obviously, libraries are necessary elements of our colleges and universities. Two practical questions that arise are: How shall the library be formed, and how shall it be used?

In discussing these question, I shall lean heavily on my own experience. Although the Engineering Societies Library is not a college library, its work is much the same. Its users are students from institutions where local facilities are inadequate, and engineers in practice or engaged in research work. Because of its unusual book collection, it is called upon to supplement the resources of many colleges, both in the United States and abroad, by supplying literature and bibliographical assistance. Its broad function, then, is to assist the student of engineering.

Until recent times, the library needs of the engineers have received rather scant attention. The physical sciences and engineering have not been adequately represented in any but the largest of our general libraries. In most colleges and universities, even those with substantial libraries, the provision for engineering has been below the level of that for other departments. Often it has been inadequate for any but the simplest needs.

Various reasons (or excuses) for this condition are given. One is that engineers in the past have not been bookish people. In the days when our profession was more of an art and less of a science than it is today, when each problem was solved through the results of past experience rather than by applying scientific principles, our literature was less helpful. Unless a closely parallel problem had been discussed, the seeker found little but broad generalities, most of which he already knew.

Another difficulty in the past was that the published works on engineering were written chiefly for use as college texts. Now, the textbook has certain definite boundaries, fixed by the level of knowledge the student brings to the subject and the time available for presenting it. Taking account of the capacity of the average student, every author finds himself limited in the amount of ground he may cover, and he can deviate from the accepted pattern only by his method of presenting the basic information.

The books of the past, therefore, being either confined to fairly elementary fundamentals or else almost entirely descriptive, have not offered much attention to earnest students. In the last few decades, though, there has been a new tendency, and a better one.

The engineer of today, to an extent never realized in the past, is aware that his activities rest upon a scientific foundation. Just as the industrial chemist always has thought that the processes he employed followed the theoretical laws of chemistry, the engineer is coming to perceive that scientific principles form the basis of all his methods.

The results are apparent in almost every branch of engineering. In metallurgy, in hydraulics, in machine design, and in communications, to name only a few examples, we see marked advances that have resulted chiefly from the study of pure science.

Out of this development are coming books of a new type. Not intended for classroom use, they can deal with more limited fields and do so more comprehensively. Basing their treatment upon exact science, they insure longer useful life for themselves. The quality and durability of our engineering libraries is improving rapidly.

A third obstacle to the development of engineering libraries has been the lack of librarians with experience in engineering. Too few librarians, unfortunately, have come from scientific and technological studies, and brought to their duties an understanding of these subjects. Confronted with the flood of publications available, they have found it difficult to choose wisely.

Under these circumstances they have had a tendency to evade the problem and turn their attention to more congenial fields, to those where their scholarship was surer and their judgment sounder.

Past conditions, therefore, have been far from ideal. A literature that was limited in scope and largely elementary, and with custodians lacking the proper qualifications, did not conduce to the growth of strong libraries. As a consequence, the development of engineering libraries has been almost entirely a twentieth-century phenomenon. Today there are a number of libraries devoted to applied science, as well as numerous departments in colleges, universities, and large public libraries that offer a wealth of such material, adequately cataloged and administered by competent librarians.

Their growth has paralleled that of our research institutions and has greatly facilitated research work. Thanks to them, it has become possible for the research worker to obtain access, in one way or another, to any published material on any subject, usually with little delay and at moderate expense. Bibliographic paraphernalia has been developed which is constantly making the literature more accessible, by providing information as to what is in print and where it can be found. New methods are being devised for copying and distributing what is needed.

Essential substance of an address "The Role of the Library in Engineering Education and Research" delivered upon the occasion of the inauguration of President O. C. Carmichael of Vanderbilt University, Nashville, Tenn., February 4, 1938. Made available for simultaneous publication in MECHANICAL ENGINEERING and *Electrical Engineering* through the courtesy of the editor of the latter journal.

The change in conditions during the past 20 years can scarcely be described.

WHAT SHOULD A LIBRARY CONTAIN?

Every library that I know (and every college, for that matter) suffers from lack of sufficient income to achieve its ideals. Engineering has been defined by Sir Frederick Bramwell as "the art of drawing sufficient conclusions from insufficient premises." Librarianship might be paraphrased as the art of collecting a sufficient library with insufficient funds. No library can afford to purchase everything. Probably no one would ever wish to do so. No library has ever achieved the ideal of cataloging and indexing. Neither has any library known to me been able to meet the multifarious needs and wishes of readers as fully as was desired.

The material of the library falls roughly into three categories: Periodicals, books, and bibliographic equipment. Of these, the first is the most essential.

If the eighteenth century were the age of the pamphlet, and the nineteenth that of the book, the twentieth is the period of the periodical. Never before has there been such a quantity and variety of magazines and journals rushing from our presses.

In such fields of active development as science and technology they have pushed the book into the background. The strength of a research library can be measured today by the size of its periodical department. It is in the periodical that one looks to find the details of new discoveries and inventions, fresh from the discoverer's mind and in his own words. Here, too, are found those hints of new fields, suggestions of unexplored paths, that are the inspiration for further investigations.

Over the book, the periodical has certain definite advantages. It can discuss subjects that either are too detailed or too limited to justify a book. It can be more timely and less formal, and can discuss a subject as it develops day by day. In the future, even more than in the past, the periodical will be first to report new discoveries, and will form the source from which material for books and inspiration for further study are drawn.

The number of periodicals, however, is amazing and far beyond the purchasing power of any libraries but the largest. Probably more than 3000 periodicals of some professional interest to engineers are now being published. In addition, there are hundreds that have ceased publication but are still of value, and new ones are appearing almost daily.

Fortunately, the usual requirements can be met by a relatively small number. Fifty periodicals probably will cover all general needs. Another fifty will be adequate for ordinary research work. Beyond this, material can be obtained as needed from other centers.

This selection of the most important periodicals is difficult. The needs and preferences of the selector are apt to influence choice unduly, and some more impersonal method is desirable. One such method, devised by P. L. K. and E. M. Gross, was described in *Science*, October 28, 1927, page 385, and illustrated by application to chemical periodicals. A few similar studies have been published, and more would be welcome. In their absence, selection must be based on the experience of other libraries with similar needs.

Complete sets of periodicals, while desirable, are by no means necessary. Most demands will be for the issues of only the last 25 or 30 years. Much money can be wasted in attempting to obtain the early volumes of older periodicals, without regard to the demand for them.

In spite of common opinion, books, as distinguished from periodicals, are of secondary importance in the engineering library. One reason for this, already mentioned, is the fact that our books are so largely written for use as undergraduate textbooks. Useful as these are for instruction and quick reference to fundamentals, it does not seem necessary to have many works that cover the same field with about the same comprehensiveness, and differ only in method of presentation. Two or three on a subject are usually adequate.

Another reason that lessens the importance of these books is that they always lag behind current knowledge and hence rapidly become too out-of-date to be very useful. Obsolescence occurs at a high rate, five years of useful life being perhaps a fair estimate. After that, most current books are either revised or supplanted by better ones.

The book collection in use at any time is therefore relatively small. Most needs can be met with remarkably few titles, say 4000 or 5000. Except for some classical works, these should be books of very recent publication, so that the factual information may be the latest available.

An active engineering library therefore might comprise 5000 books and, perhaps, 2500 volumes of some 50 periodicals. As new books appear, others are withdrawn. If it is desired to keep them, they can be retained as a supplementary collection, and this is desirable if space permits, for they sometimes will be wanted for the research worker or historian. But in beginning, these uses may be neglected and attention focused on immediate requirements only.

Supplementing the books and periodicals, every library should have adequate bibliographic equipment. This consists of indexes, abstract journals, and bibliographies.

No library can have too many of these aids to research. The smaller the library, the more important they are, for they provide guides to what has been published, and what is not available locally can usually be obtained, if its existence is known. Abstract journals also often supply all that is needed for ordinary purposes. In many cases they make it unnecessary to have the original periodicals and so are an economy, in spite of their relatively high cost. Such publications as *Engineering Abstracts*, *Science Abstracts*, *Chemical Abstracts*, and *Metallurgical Abstracts* are fundamental necessities to every research library.

The number of abstracting services is large, and is increasing as our literature becomes more voluminous and complex. Considerable overlapping exists, but is not a cause for worry, as the abstracting and indexing vary with the different viewpoints of those for whom the services are intended. Although the ideal would be a single publication which abstracted and indexed everything from all points of view, that ideal never will be reached, or even approached, in our day.

These journals, together with such indexes as the *Engineering Index* and the *Industrial Arts Index*, and the national bibliographies of the leading countries, are the means through which any research problem is most easily approached.

HOW IS THE LIBRARY USED EFFECTIVELY?

Tedious as library research is, it indubitably is the proper first step in any investigation. No better means exists for ascertaining the extent to which any field has already been covered, the results obtained, and the points where further study is needed. Much time-consuming, expensive experimental work can be avoided through the library. Every experienced librarian can cite specific instances of work which was done twice, often at large expense, because through insufficient reading the first investigation was unknown to the later student. Large sums have been invested in patents that were overthrown by searching the literature at relatively small cost.

Assuming that we have acquired our library, a modest collection of perhaps 10,000 books and volumes of periodicals and index journals, how shall we use it effectively? Here we approach an art that each must learn for himself. Methods will

vary with individual tastes and with the fields of study. There is no universally applicable technique, nor can any one lay down rules that appeal to every worker.

A good method is first to ascertain whether any comprehensive treatises exist, by examining the most comprehensive bibliographies available. As a preliminary, this treatise will serve as a summary of work prior to the date of publication, or approximately so. Often use of it will obviate the need for examining earlier periodical literature or, if it does not do so, will provide convenient references to the relative articles.

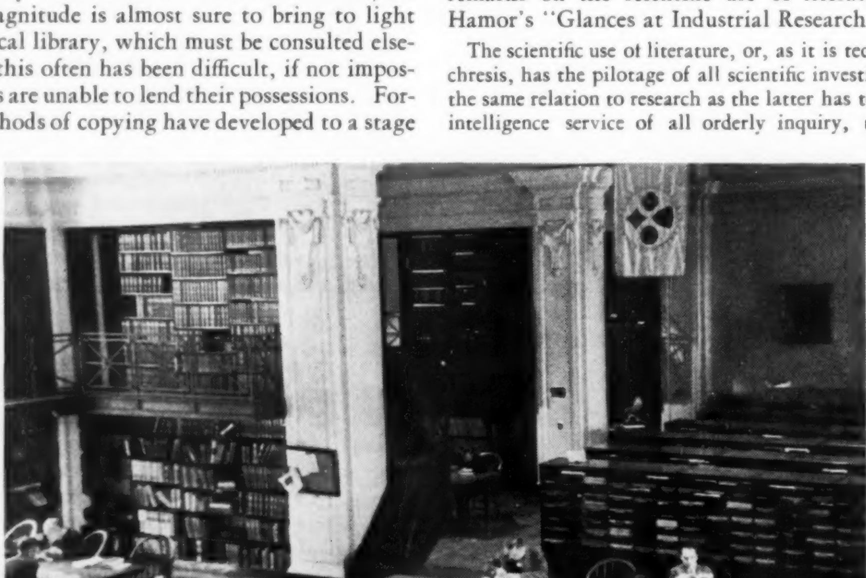
Subsequent to the date thus established, the first search is for bibliographies that will be helpful. Usually none can be found, or those found are suspiciously brief and incomplete. Except for those lucky occasions when a satisfactory bibliography is to be had, one may as well turn at once to the abstract journals and engineering indexes, compile his own list of references that offer promise, and obtain these by consulting the originals.

Proceeding in this way, one is enabled to cover the subject as thoroughly as the occasion requires or as time permits. Eventually, it is possible, or should be, to disinter everything that has been published. This, however, is seldom done and the "complete" bibliography is exceedingly rare.

As thus outlined, the searcher's method seems very simple. Actually, of course, complications arise that call for all his skill and knowledge. Indexing and classifying are arts that are far from perfect, and it often is difficult to trace the desired subject through all the vagaries of various workers.

In different indexes various names are used for the same things. Terminology changes from time to time. Articles that fall into one group when classified by a physicist sometimes are classified quite differently by an electrical engineer. Practically never does one index or abstract journal cover its field completely. In addition, indexes seldom go beyond the main subject of an article, and nothing but direct examination will discover the hidden information within it. All these difficulties arise to hamper the searcher, but if he is sufficiently persevering and industrious, he eventually will find what exists on his subject.

A search of any magnitude is almost sure to bring to light material not in the local library, which must be consulted elsewhere. In the past, this often has been difficult, if not impossible, as many libraries are unable to lend their possessions. Fortunately, modern methods of copying have developed to a stage where material can be copied cheaply and accurately. The use of the Photostat has spread rapidly in recent years, until most libraries can supply photographic copies. Very recently attention has been directed toward microcopying upon film, a method of great promise for the research worker. The "microfilm" method is especially valuable for reproducing long documents, such as complete books, more cheaply than was possible in the past. Some form of projector is necessary to produce a readable image, and a variety of apparatus is already available.



READING ROOM, ENGINEERING SOCIETIES LIBRARY, NEW YORK, N. Y.

Through the development of bibliographic equipment which enables librarians to ascertain where given documents exist, and of good methods for reproducing them, the entire book resources of the world are rapidly becoming accessible to every worker, regardless of his location. Current tendencies undoubtedly will affect the management of the college library. No longer will it need to be considered as an isolated institution that must rely wholly on itself; instead, it may be considered as one of a system of cooperating organizations, with resources pooled to a certain degree. Intelligent use of the facilities available for obtaining seldom wanted material through means other than direct purchase should release funds that can be used more effectively for ordinary needs.

An engineering library may be regarded as a laboratory. Like other laboratories, it is a place for study and research. Like them, its assets are personnel, equipment, and housing. Also like them these assets are important in the above order. A good librarian will get better results with meager equipment than a poor one can get with all the books in print. The best collection of books possible is desirable, but best and largest are not synonymous terms. Good housing is always an advantage, but to sacrifice books and personnel for a handsome building is a frequent mistake. After all, the Curies did their brilliant work in a shed, and many libraries are giving excellent service in poor quarters.

Because the library is an essential tool in research work today, and promises to become even more important hereafter, college students would profit immensely from more instruction in its use. Too many leave college with no idea of the technique of searching, and hence find themselves helpless when cut off from professional advice. If, from time to time, problems were assigned for solution in the library, instead of the laboratory, this might be corrected to a degree. No better description of the rôle that the library can play in research is to be had than the remarks on the scientific use of literature in Wiedlein and Hamor's "Glances at Industrial Research:"

> The scientific use of literature, or, as it is technically termed, bibliochresis, has the pilotage of all scientific investigation. It has, in fact, the same relation to research as the latter has to management; it is the intelligence service of all orderly inquiry, the preparational agent of factual determination, the guide of experimental trial in eliminating chance, in the whole realm of science, whereby the sedulous worker his laboratory course does steer.

These distinguished research workers speak warmly of the necessity of literature search as the prelude to experimental investigation. It prevents waste through needless repetition; it is also, they say, a necessary "discipline for the self-conceit of the researchful mind."

INSPECTION METHODS *in* INDUSTRIAL PLANTS

By CARL L. BAUSCH

BAUSCH & LOMB OPTICAL CO., ROCHESTER, N. Y.

INSPECTION methods are installed in industrial plants for two reasons: (*a*) to insure the customer's receiving a product suitable to his wants, and (*b*) to give the manufacturer proper control of his quality for maintaining his reputation and a proper level of manufacturing costs. Most manufacturers, regardless of what quality level they are in, want to feel that they are the leaders in that level. The manufacturer who is the leader in the top level in his industry usually wants a product that is near perfection. He wants each piece to be like the one that preceded it and like the one to follow. Many believe that this can be done, but most engineers know it cannot.

STANDARDS ESTABLISHED SHOULD SATISFY CUSTOMERS

There are no two things alike in the world. We hang a murderer in perfect confidence that we have the guilty party because his fingerprints match the prints of fingers left on a weapon at the seat of a crime. Of all the millions of fingers in the world, we are taught by research and experience that no two are alike. We are sure that a bullet was fired from a certain gun because it has markings on it left by the rifling of the gun that we are sure differs from the rifling of every other gun in the world. The manufacturer who made the gun tries to have the rifling in all his guns of one type the same. In the eyes of his customer who wants the gun for target practice, he does, but not in the eyes of the ballistics expert at the murder trial, and the expert usually has no trouble in convincing the jury that he is correct.

How good should we make our product? It would be foolish for the gun manufacturer to try to perfect his product so that the ballistics expert could not tell the rifling in one from the rifling in the other, but, if he wants to be a leader, he must have them near enough alike so that in the eyes of his customer, who is the sportsman, they are alike as far as functioning goes. We can never do such a good job of duplicating any product but what the highly skilled expert with proper facilities can detect differences. Our problem then becomes one of sizing up our customer and setting standards and limits to insure a product that he will accept with confidence and satisfaction and a product that can be made at a profit.

To set proper standards, we must put ourselves first of all in the shoes of the customer. Then we must listen to the point of view of the manufacturing division. This phase of the work is a vital one. A manufacturing concern can easily be made or broken at this point. Although all standards are probably a matter of growth, being built up and altered as complaints come in from salesmen and customers, it behooves the manufacturer who wishes to be successful to set his standards after mature thought in advance of manufacture. If a manufacturer does not have confidence in his standards of quality, his organization will be in constant turmoil brought on by daily complaints and suggestions, the turmoil being occasioned by the fact that the manufacturer does not know himself just what is and what is not right. It is usually desirable for a manufacturer to adopt a policy of one general level of quality as it is a difficult task to keep an organization geared up to handle different grades of product. Of course, many methods can be followed in going about the task of setting a standard. A thorough knowledge of market conditions, competitive quality, and manufacturing problems is necessary.

CHANGE IN SIZE OF STANDARD REDUCES WASTE BY 80 PER CENT

In the following paragraphs, an example is taken from the experience of the Bausch & Lomb Optical Company showing how a standard was set covering the size of the reading segment on a new type of fused bifocal lens. The size of this segment must be such that the wearer can read through it in comfort. Variation in size must be of such an order that if the smallest allowable size is matched with the largest, the difference is not noticeable to the observer. The correct size was taken arbitrarily as 14.3 × 20.9 mm, with limits of ± 0.4 mm on width and ±0.5 mm on length. After tools were made and small production was run off, a lot of lenses were measured for segment size and the results tabulated as shown on the chart, Fig. 1. The figures represent the number of lenses of each size with the segment size shown by the coordinates. The results showed that 1283 lenses of a total of 2244, or 57.2 per cent fell within the limits. If the standard for length was raised 0.4 mm, from 20.9 to 21.3 mm, it was found that 1878 lenses or 83.7 per cent would qualify. This increase in length would save a large tool expenditure and would be just as desirable to the customer, so the decision was readily made to change the standard. The argument was then advanced that if the tolerance on width was made the same as on length, or ± 0.5 mm, the output of good lenses would be raised to 91.8 per cent. Tests showed that this extra 0.1 mm could not be easily detected in use, so the limit was finally set at this last figure. To satisfy those wanting extreme control of size, it was decided to pack these lenses in four groups and mark the group sizes on the container. These sizes were

13.8 to 14.3 × 20.8 to 21.2	13.8 to 14.3 × 21.3 to 21.8
14.4 to 14.8 × 20.8 to 21.2	14.4 to 14.8 × 21.3 to 21.8

Through this study, it was possible to give the customer less variation in size than was originally expected, and it was also possible to reduce losses from 42.8 to 8.2 per cent.

Across the bottom of the chart are given the percentages of different widths on two different lots of product at different dates which show the relative constancy of variation. This is an example of setting a standard on a type of characteristic that can be actually measured. On such characteristics, it is fairly easy to write inspection specifications. Characteristics that are not subject to measurement are much more difficult to handle. On these, descriptive specifications are necessary, and usually nice judgment is required in using them.

On this type of inspection, operators tend to become more

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PANOPTIK SIZES — September 5, 1933

	20.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	21.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	22.0	.1	.2	.3	.4	.5	.6	.7	Total	%
13.0																														
.1																														
.2																														
.3									1																				1	-
.4																														
.5									5		6	1	2	3		2					1								20	0.9
.6						1	1		1	1				2															6	0.3
.7									3		5		1	2															11	0.5
.8						2	2	4	23	2	25	5	7	17	1	3													91	4.1
.9																														
14.0						2	5	6	62	9	130	71	35	101	9	48	5	3	4		2	1							493	22.0
.1							1	1	6	2	18	9	6	17	1	4	2	2	2										71	3.1
.2								1	4	1	39	17	13	26	3	13	2	1	2			1	1			1			125	5.5
.3						1		2	24	2	72	45	39	137	20	100	23	14	14	2	4	4		1		1			505	22.5
.4																														
.5									7	1	42	43	40	157	21	165	55	36	50	3	14	4	3	1		2			644	28.7
.6											2	1	1	5		7	5	7	11	1	4	1							45	2.0
.7											2	3	1	15	5	13	9	5	12	1	11								77	3.4
.8											1	1	1	20	3	29	7	10	27		7	2	2			1			111	5.0
.9																														
15.0														3		6	2	3	11		7	2		1	1	1			37	1.7
15.3																			1			2	1	2		1			7	0.3
Total						6	9	14	136	18	342	196	146	505	63	390	110	81	134	7	50	17	7	5	1	7			2,244	
%						0.3	0.4	0.6	6.1	0.8	15.3	8.7	6.5	22.5	2.8	17.4	4.9	3.6	6.0	0.3	2.2	0.8	0.3	0.2	-	0.3				
August 31 - %.				0.1	0.0	0.2	0.3	0.2	1.4	0.5	8.4	7.1	7.4	24.5	4.9	20.4	7.7	4.5	7.1	0.6	2.4	0.6	0.4	0.6	0.0	0.3	0.1			

FIG. 1

critical as they gain in experience, and costs are apt to be run up without benefit to the customer. In such cases, it is desirable to have samples showing passable and nonpassable defects. Proper supervision on this type of inspection is important.

UNMEASURABLE QUALITY VARIATIONS

Changes in equipment and material often introduce variations in quality of this unmeasurable type that requires expert judgment in setting the necessary new variations in standards. Changes in customer's demands is another variable that brings about conditions that must be carefully watched by the supervision. The personal equation is often put to work when pressure for delivery from the service department becomes heavy. Such pressure will often ruin the judgment of the best operator.

The more these characteristics that cannot be measured are eliminated, the better the inspection job can be done. Recent developments have done much to improve this condition. Spectrophotometers and other color-measuring tools have eliminated to a large extent the need of personal judgment in matching color. Surface finishes can be measured with profilometers and comparison microscopes. Noise in mechanisms can be evaluated by a special microphone with amplifiers and a mirror system to show shape and amplitude of sound waves. Shapes can be quickly measured by profile projectors. The photoelectric cell has replaced the human eye in many inspection operations. Science is rapidly removing guesswork from this type of inspection problem as it has in the past from the mechanical measuring field.

Proper inspection methods will usually give the manufacturer a tool with which he can control manufacturing procedure. Without this aid, the manufacturer would not dare let loose the production pressure that is so necessary in our modern highly competitive system. Through a proper inspection system, defective work can be discovered and its causes removed before large production is built up. Big savings in elimination of scrap and consequent cost reductions are possible. The proper system will often disclose defects that start in a small way long before serious trouble is occasioned in the trade.

FINAL INSPECTION AN ENGINEERING-DIVISION FUNCTION

To get the proper broad view, the inspection department that sets the standards and checks the final product should be an independent branch of the business, responsible to either the executive head of the business or the head of the engineering division. In large plants, where it is desirable to put more responsibility on the manufacturing head, the final or check inspection function may be under engineering and material and part inspection under the manufacturing division. It is the author's experience that such a division is desirable.

The final inspection should represent the viewpoint of the customer, while it is often advisable for the parts inspector to have the viewpoint of the manufacturing department, so that the element of selectivity in assembly can be exercised to the advantage of the cost factor.

There are other good reasons for the final-inspection department to be closely related to the engineering department. Close cooperation between these two functions of a business will help in producing better designs, as the viewpoint of the inspection department is of great help to the designers.

Construction and inspection specifications should be closely tied together. As an example, in setting final-inspection specifications for a microscope objective, characteristics such as resolving power, flatness of field, definition, color correction, exactness of magnification, interchange of fit on the microscope, and the like are involved. These characteristics of the finished product are obtained by proper design, but certain variables can be juggled to some extent to obtain the final result. The index of refraction and dispersion of the glass and the radius of curvature, thickness, centering, and spacing of the lenses can all be varied in relation one to the other in some degree to obtain this. The material and parts inspection in such a case can properly be classed as a function of the manufacturing division.

In setting standards for final inspection, full consideration should be given to competitive product, either by direct comparison with one's own product or through reports from the outside. The direct-comparison method is usually desirable but must be tempered, of course, by what we hear of the customers' opinions regarding that product. Standards for final inspection should cover the phases of function, durability, and appearance.

In setting standards for a new product similar to some established product, a review of the complaint file on the old product is desirable. When investigating trade likes and dislikes, one must guard constantly against taking a regional opinion for a national or international opinion.

Regional differences of opinion vary to such an extent that a

real problem is often presented in arriving at specifications that suit all sections of the territory from which sales are expected. The eastern section of the United States wants thin spectacle lenses, while the Middle West wants them thick. One section of the country wants spectacle temples stiff, while another wants them more flexible. Often, the difference of opinion is so great that specifications cannot be written to suit all, and a decision must be made regarding what section to cater to.

ACTUAL EXAMPLE OF FINAL-INSPECTION PROCEDURE

Knowing that examples are helpful in visualizing a problem, the author will discuss the final- or control-inspection procedure used in the plant of the Bausch & Lomb Optical Company. The chief inspector in charge of this work is directly responsible to the vice-president in charge of research and engineering, while the material, tool, parts, and manufacturing inspection is handled by the manufacturing division.

The chief-inspector's office has drawn up inspection specifications and set standards on all present product. These specifications are of a definite written form, but, often with the more simple product, samples showing different defects are also included as a part of a specification. Complete complaint files are kept up-to-date, all complaints finally finding their way to this office. They are studied as to their justification and classified the same as the inspection records so that a comparison can be made between the findings of the department and those of the customer. A lack of similarity in these findings is taken as a danger sign that the standard or its maintenance is at fault. Usually, the customer's version is taken as correct unless it involves some technical point that he may not understand.

The inspection department conducts, or has conducted, all breakdown tests on samples of suggested new product after the engineering department has given its own release on the product. Tests are also conducted on competitive products that are periodically acquired. The question of how much money should be spent on such activity is difficult to answer and requires nice judgment.

As a matter of organization, the department is divided into two branches; instruments and ophthalmic lenses and frames. All instruments receive a complete inspection while ophthalmic lenses and frames receive a check or control inspection, by the final-inspection department after a 100 per cent inspection by the factory organization.

Instrument inspection is largely one of use, the items being put into actual use by the inspectors in the same way they would be used by the customer. Records on this type of work should show the types of defects that appear on different groups of instruments so as to give the operating heads of the business a convenient tool with which to attack the trouble. An example of such grouping of defects by types is

(1) Defective optically
(2) Defective mechanically
(3) Defective finish
(4) Out-of-adjustment optically
(5) Out-of-adjustment mechanically
(6) Defective material
(7) Oversight or careless mistake
(8) Faulty design
(9) Not according to specifications
  (*a*) optically
  (*b*) mechanically

A study of these reports discloses tendencies that make possible the application of corrective measures.

10 PER CENT SAMPLING GIVES SUFFICIENT CHECK ON PRODUCTION

The ophthalmic-lens and frame inspection is one largely of measurement and observation, some of the product being put to destructive tests. Numerous attempts have been made to devise formulas to lead one to the proper solution of how to make check inspections such as are used in this ophthalmic division. The Bausch & Lomb Optical Company has arrived at the answer by a cut-and-try method which we believe satisfies the conditions. Both lens and frame divisions are using about a 10 per cent check. That is, samples representing 10 per cent of the total production are inspected after the complete manufacturing inspection has taken place. These samples are taken at random or are definitely picked out of production by the inspection department. If they are not satisfied with the results of the check inspection, they reject entire lots of the product and send them back to the manufacturing department for a 100 per cent reinspection.

A careful study of complaints seems to justify the belief that this 10 per cent sampling, as conducted, gives a good cross section of the product and prevents, to a large extent, faulty product getting through to the trade. Table 1 gives figures that

TABLE 1 RELATION BETWEEN PRODUCTION AND REJECTIONS ON FRAMES

	1936	1937
Units produced	4,330,000	5,387,000
Units inspected	453,000	584,000
Units rejected	4,077	4,023
Complaints	199	175
Complaints per $100,000 of sales	9	7

serve as examples of how the relation runs between production, inspection, rejects, and complaints on certain spectacle-frame items. These figures clearly indicate that over these two years quality improved and complaints declined.

The figures in Table 2 show a similar relationship for spectacle lenses. In the lens department, an attempt has been made to evaluate different characteristics of quality so that a rating of quality for all defects is obtained. A number of points totaling 100 is allocated to the various factors that go to make up quality, according to an arbitrary relative value. Using these ratings on the check inspection of both Bausch & Lomb and competitors' products purchased in the market, the following was shown for single-vision and certain bifocal lenses.

TABLE 2 RESULTS OF CHECK INSPECTION OF BAUSCH & LOMB AND TWO COMPETITIVE LENSES

	Single-vision		Bifocal	
	1936	1937	1936	1937
B. & L. lenses, points	91.9	92.9	97.8	97.7
Competitor *A*'s lenses, points	90.4	92.1	81.0	85.3
Competitor *B*'s lenses, points	85.6	91.1	77.9	82.8
Total complaints	572	538	885	883
Complaints per $100,000 of sales	42	36	111	79

TABLE 3 PERCENTAGES OF PRODUCT FALLING WITHIN CERTAIN ZONES

	Zone			Rejected
	1	2	3	
January, 1938	61.0	36.1	1.8	0.1
Average, 1937	65.2	32.6	2.0	0.2

These figures do not show the volume of production except that the last line "Complaints per $100,000 of sales" takes volume into consideration. They show in the case of both single-vision and bifocal lenses that, with improved quality measured on this basis, fewer complaints are received. What appears as a discrepancy between the ratings and complaints on single-vision and bifocal lenses, where the higher rating of the latter was tied up with more complaints rather than less is probably accounted for by the fact that the price of the bifocal lens is about three times as much as that of the single vision,

and, therefore, although the quality rating of the bifocal is higher, the complaints are more numerous. Whether the rating values are correct or not, the system gives one a criterion by which progress can be watched. This phase of the system has been in use for only a short time and further experience will probably show more evidence of its value.

Variations of quality within specified limits can often be of such a nature that product inspected under such specifications will vary considerably within these specifications from time to time. As an example, the degree of departure from a perfectly centered lens is a characteristic of a spectacle lens that should not vary beyond a certain limit because of the prism effect that is introduced before the eye. Limits on different-power lenses are set so that no harmful effect to the eye is possible.

The actual amount that the optical center differs from the mechanical center, if within limits, is not important, but, because it is a characteristic that can be easily measured and can be made a sales point, a record is kept to show the average amount of variation, and an effort is made to keep this variation down to a low figure regardless of the tolerances. This is a case where it is probably advisable to state a percentage of product that should fall within a certain zone. The figures in Table 3 show how this might work out. The standard in this case is that 60 per cent should be in the first zone and not over 5 per cent in the third zone. The condition, therefore, as shown by the record is satisfactory.

A mathematician reading this paper would probably be disappointed as no attempt has been made to present or derive exact and statistical laws for the guidance of the inspector. Results from the use of such laws are only as good as the data that go into them. The many variables covering characteristics, ratings, ability to measure, and errors in measuring and judgment make, in the mind of the author, too many obstacles for feasible application in ordinary industry. If the author has offered something in this paper to serve as food for further thought and discussion, he is well-satisfied.

A Practical Point in PUBLIC SPEAKING

The Proper Use of Mimeographed and Printed Material

BY S. MARION TUCKER

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MOST SPEAKERS so misuse their mimeographed or printed material, to be distributed among the audience, as to hurt their speeches and seriously distract their auditors. So much so that the material often does more harm than good. So much so that the time spent on its careful preparation is largely wasted.

The *timing* has to be just right. The mere mechanics of distribution have to be planned and have to work smoothly. The entire business has to run like a well-oiled and smooth-running machine, doing its work quietly and efficiently and calling no attention to its working.

Basic Fact: If mimeographed or printed material, intended for distribution to the audience, is to achieve its proper effect, it must be used at the right moment and in the right way. Otherwise, it will be at best comparatively ineffective, and at worst will be a source of disturbance to both speaker and audience. A few simple rules of procedure follow:

(1) The material should be on hand, in the right place, and in sufficient quantity.

(2) The material should be distributed at just the right moment, not ahead of time, and not too late, either.

(3) If the material is needed right at the beginning of the speech, it should be distributed immediately after the opening of the speech or even before the speech has begun.

(4) If it is to be used at some particular juncture of the speech, it should be distributed just at that juncture, not a moment before.

(5) If it is not actually to be discussed by the speaker, or if the audience does not need to see it while it is being discussed, it should not be distributed until the very close of the speech. The speaker will state that it will be distributed afterward.

(6) If the speaker wants the audience to look at the material, in order to cooperate with him, even mentally, in his comments on it, *he should wait until all of it has been properly distributed before he begins his comments.* He should never under any circumstances try to talk about it, or talk about anything else, while the material is being distributed. This is a common fault of speakers who want to rush things and who assume that the audience, while more or less disturbed by the inevitable stir caused by the distribution, can do two things at once and equally well: (*a*) look at the material, and (*b*) listen to the speaker attentively. It cannot be done.

Even though the speaker lose a few moments, he had much better wait in utter silence until the necessary job of distribution, with its inevitable distraction, has been entirely finished and the flutter has subsided. Then he can begin again, with an attentive, composed, and satisfied audience.

(7) If the audience is small, and if the speaker is placed conveniently to do it, he may of course distribute the material himself; but otherwise this may prove impracticable. In the latter case:

(8) He should make arrangements ahead of time with one person or several persons, depending upon the size of the audience or the auditorium, to distribute the material. Each helper should have in his hands several sets of the material, each set capable of supplying one row of auditors. He hands his first pile of copies to the first auditor in the first row on the aisle, asking him to pass the copies across. He hands his second set to the first auditor in the second row on the aisle; and so on down the line. At the same time, another helper is doing the same thing on the other side of the auditorium. In this way, only two helpers can within only a few moments, with the always ready cooperation of the audience (which dearly loves to have such material handed out to it), supply everybody in the house. When we try this simple and expeditious method of distribution, we find that it goes without a hitch and works phenomenally fast, to the entire satisfaction of all concerned. *But it should be planned in advance.*

Fifth in a series of articles on the presentation of technical papers.

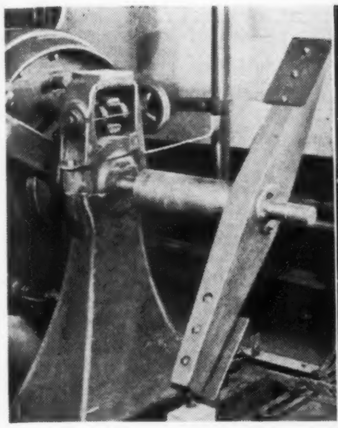

Fig. 1

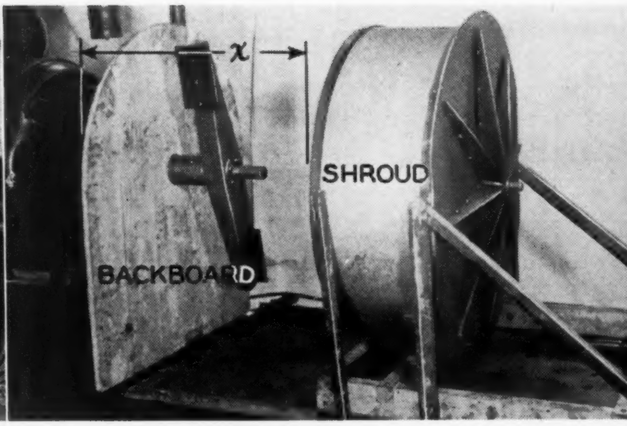

Fig. 2

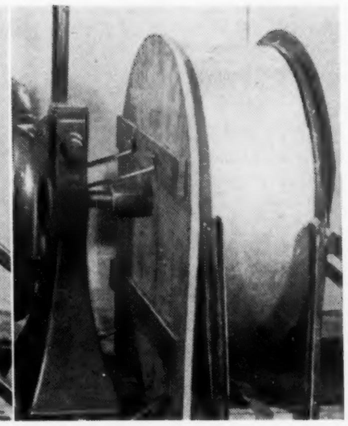

Fig. 3

FIG. 1 UNOBSTRUCTED HALF-SCALE MODEL; FIG. 2 HALF-SCALE MODEL EQUIPPED WITH BACKBOARD AND OPEN SHROUD; FIG. 3 HALF-SCALE MODEL COMPLETELY ENCLOSED BY SHROUD

Further Investigation of the AERODYNAMIC DYNAMOMETER

By KENNETH G. MERRIAM and ARTHUR J. STAPLES

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RECENT literature (1, 2)[1] conveys the impression that the aerodynamic type of dynamometer is not held in high regard. This is not strange, because most existing forms of the device, usually referred to as air or fan brakes, provide for neither accurate measurement nor convenient variation of torque.

Yet, aside from its low cost and simplicity, the air brake is intriguing. Torque varies as the square, and power absorption as the cube, of the speed. This means that self-regulation is assured and that the device is well-adapted for absorbing power delivered by high-speed prime movers, such as internal-combustion engines. Also, for geometrically similar brakes, power absorption varies as the fifth power of the brake diameter for constant speed.

The complete law, stated in familiar form, is

$$P = C_p \rho n^3 D^5$$

where

- P = power absorbed, hp
- ρ = air density, lb per cu ft divided by 32.2
- n = speed, rps
- D = brake diameter, ft
- C_p = dimensionless power coefficient which, like other aerodynamic coefficients, is a function of "effective shape" and Reynolds' number.

Believing that a device possessing such interesting characteristics is worthy of further investigation, the authors designed and supervised a series of tests which were executed by aeronautical-engineering students (3) at Worcester Polytechnic Institute. The purpose of this paper is to present tentative conclusions arrived at as a result of some of these tests.

The prototype for all models tested was the Gar Wood Liberty-12 test club (4), which was used in the Worcester Polytechnic Institute engines laboratory for absorbing power delivered by a Liberty-12 engine. Third-scale and half-scale models were made, based on 14 × 8-in. plates for the prototype. Fig. 1 shows the half-scale model driven by a Sprague dynamometer that was used as the prime mover and measured torque. Although the 62-in. diameter prototype absorbed over 400 hp at 30 rps, at the same speed, the third- and half-scale models were expected to, and did, absorb only about 1.6 and 12 hp, respectively, so that the 50-hp Sprague unit was really oversize and barely sensitive enough for the third-scale application.

POWER-COEFFICIENT VARIATIONS

Each of the two models was tested at speeds ranging from 20 to 32 rps. For the half-scale model, no systematic variation of the power coefficient with the speed was found, all values varying less than 1.2 per cent from the average, 17.1×10^{-4}. For the third-scale model, with $n > 28$, C_p values varied less than $^3/_4$ per cent from an average of 17.1×10^{-4}. As n decreased from 28 to 20 rps, values of C_p decreased to the minimum of 16.1×10^{-4}.

No tests were performed with the full-scale club, which could not be powered by the Sprague unit, but values of the power coefficient, computed from data in report No. 744 of the engineering division of the Army Air Service (4), showed no systematic variation with speed, values varying about 3 per cent from an average of 18.3×10^{-4}. The inference is, then, that the power coefficient is essentially not a function of the

[1] Numbers in parentheses refer to the Bibliography.

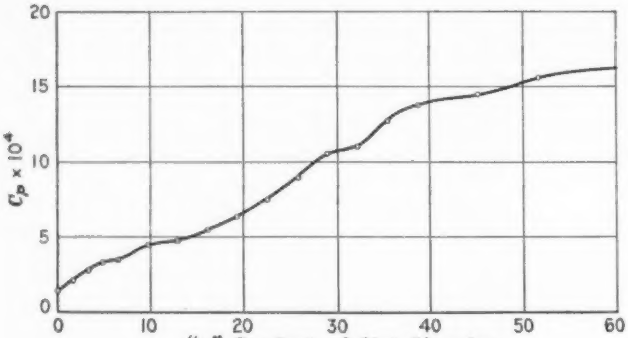

FIG. 4 TYPICAL VARIATION OF POWER COEFFICIENT WITH DISTANCE FROM BACKBOARD TO LEFT EDGE OF SHROUD

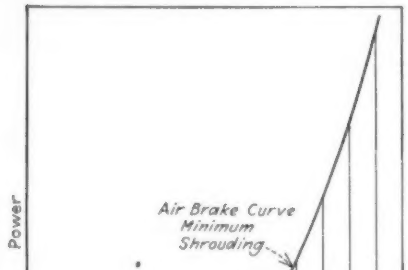

FIG. 5 CURVE SHOWING HOW SHROUDING OF A CLUB BRAKE MAKES POSSIBLE THE INVESTIGATION OF ENGINE POWER-SPEED RELATION FOR SPEEDS VARYING BETWEEN 70 AND 130 PER CENT OF THE NORMAL OPERATING VALUE

speed in the range covered by the tests, except in the low-Reynolds-number region reached by running the third-scale model at low speeds.

Although the value of the power coefficient for the third-scale model has been stated as 17.1×10^{-4}, check measurement of the model showed that the value for the diameter was 0.65 per cent too large, although other dimensions were in third-scale proportion. A correction for this would reduce the power coefficient by something less than the 3.25 per cent correction which would obtain if all dimensions were 0.65 per cent too large. The inference is, then, that the power coefficient is essentially not a function of the brake diameter for the two models tested. It must be evident, though, that the power absorbed is exceedingly sensitive to small changes in the brake diameter.

Varying either the speed or the brake diameter naturally causes a variation in Reynolds' number. The inference is, therefore, that for the range covered by the tests, the power coefficient is essentially insensitive to changes in the Reynolds number.

The term "effective shape" is used here to include not only the shape of the club itself but also the relative location and shape of all elements of the environment which might influence the nature of the air flow and, hence, the power coefficient.

It had long been known that the power coefficient was considerably influenced by changes in the effective shape. To get quantitative information on this matter, the arrangement shown in Fig. 2 was used. The cylindrical shell or shroud, having one open end, moves on a track so that the distance x, from the left edge of the shroud to the wood backboard, could be varied from about 0.75 D to zero (see Fig. 3). Variation of the power coefficient with x, for 12 values of speed covering the range between 20 and 33 rps, was then determined, using not only the setup in Fig. 2 but also using the third-scale model with nearly geometrically similar shroud.

For the half-scale model, it was found that the several hundred data items could be fairly represented by the curve shown in Fig. 4. For the third-scale model, the curve had the same shape but was displaced downward slightly.

The inference is that the power coefficient is a continuous function of x and that it can easily be varied from the maximum to a value of about 10 per cent of the maximum, a feature of great interest to one who is trying to improve the usefulness of the air brake.

USE OF THE AIR BRAKE AS A DYNAMOMETER

If the power coefficient is essentially independent of the speed and the brake diameter for geometrically similar clubs but can be controlled and measured, indirectly, by means of some parameter such as x, then the shrouded club device should be useful as a dynamometer. No water or electrical connections are required and no problem is involved in dissipating heat. Although the power absorbed P is a function of ρ as well as the power coefficient C_p, ρ is easily determined by thermometer and barometer and usually does not vary during a test.

Referring to Fig. 5, it will be seen that any form of air brake is probably capable of loading a gas engine, even at full throttle, in the range between 70 and 130 per cent of normal operating speed, provided the brake be designed, as it can be, to absorb the full engine power, with minimum shrouding, at the lowest test speed. The vertical arrow-tipped lines are intended to indicate how the cubic curve is made to conform to the engine curve, by shrouding or varying x.

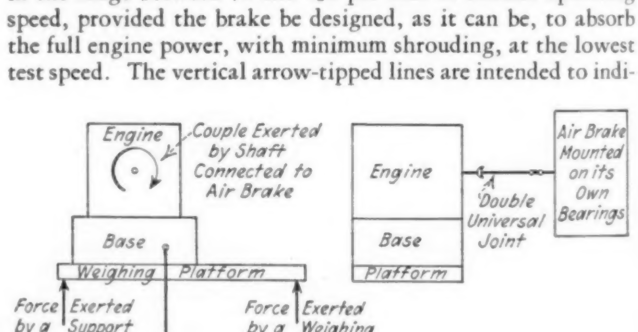

FIG. 6 SCHEMATIC REPRESENTATION OF ONE METHOD OF MEASURING ENGINE TORQUE WHEN THE SHROUDED CLUB IS USED AS A LOADING DEVICE

To make the device shown in Fig. 2 capable of 1 per cent accuracy as a dynamometer, probably tip clearance between the club and the shroud should be enlarged, and the air circuit should be improved, perhaps by admitting some air axially. This might have the effect of smoothing out the curve in Fig. 4.

Even if devices similar to that in Fig. 2 are never used to determine the power absorbed by the aerodynamic means outlined, they should prove much more useful than the old form of brake for which the power at a given speed could be varied only by stopping the engine and attaching different plates.

If the shrouded club is to be used simply as a loading device, some provision must be made for measuring torque mechani-

cally. For a small engine, this can be done by cradling the engine, with the center of gravity of the engine assembly slightly below the axis of suspension and with provision for eliminating unwanted torque from engine connections. For larger engines, the arrangement shown in Fig. 6 would seem to be a possibility. Finally, recent development of differential planetary direct-transmission torque-measuring devices may greatly simplify the torque-measurement problem.

From the foregoing, the inference seems to be that immediate extension of usefulness of the air brake is now in order and that steps should be taken to perfect the device with a view to eventual use as an aerodynamic dynamometer.

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TENSION-IMPACT TESTING

Tensile Forces During Impact Recorded Photographically

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THE TENSION-impact, as against the usual notched-bar test, is beginning to receive more and more attention and is being used to an increasing degree. Tests of this new type have been under way for a period of about two years, at the California Institute of Technology, sponsored by the following group who are interested in the impact problem: Allis-Chalmers Manufacturing Company, Caterpillar Tractor Company, General Petroleum Corporation of California, Hughes Tool Company, Lane-Wells Company, The National Supply Company of Delaware, Arnold Pfau, Union Oil Company of California, W. M. White, and A. O. Smith Corporation.

One of the principal aims of this research has been the development and construction of suitable apparatus for the measurement of impact forces. An Izod pendulum-impact machine is used. The duration of the impact is of the order of 0.001 sec with a striking velocity of 11 fps. The tensile forces which act on the specimen during this short time interval are picked up electrically as voltage changes. After sufficient amplification, these voltage changes are applied to the vertical deflection plates of a cathode-ray oscillograph. In this way, the forces appear as a force-time diagram on the screen of the oscillograph tube where they are recorded photographically. Fig. 1 shows a typical photograph obtained in this way. A wave of known frequency gives the time scale for the horizontal sweep, and the force scale, obtained from a static calibration, is put on in the vertical direction. A check of these calibrations and of the linearity of the measuring system is obtained by the law of conservation of momentun, according to which the time integral of the impact forces, i.e., the area of the photograph, is equal to the change in momentum of the pendulum. This change can be calculated from the energy readings on the pendulum machine before and after the blow.

From the force-time diagram, force-elongation and stress-strain diagrams may be obtained readily. These derived diagrams allow a further check on the reliability of this method of determining dynamic forces. The area of the force-elongation diagram should be equal to the energy given up by the pendulum, and the elongation in the diagram should be the same as that measured on the ruptured specimen.

These dynamic stress-strain diagrams allow an interesting comparison with the corresponding static-tension diagrams. This method represents a step forward in the field of testing materials.

It has been the authors' opinion for some time that stress-strain diagrams obtained in tension impact are of far more value

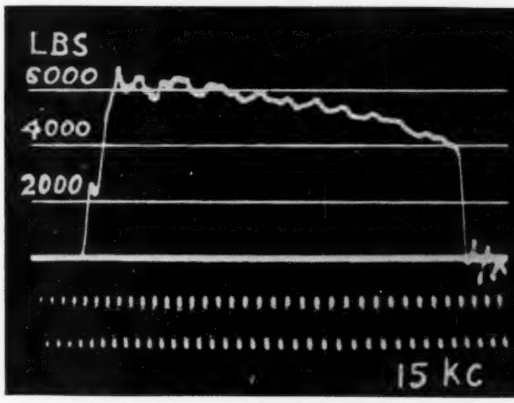

FIG. 1 TYPICAL PHOTOGRAPH OF TENSILE FORCES OBTAINED BY A CATHODE-RAY OSCILLOGRAPH IN A NEW METHOD OF TENSION-IMPACT TESTING

in determining the relative impact resistance of materials than the customary notched-bar test. The Charpy and Izod tests are not so much tests that primarily bring out the ability to withstand shock as tests that show how the metal responds to the stress system produced by a notch. But if a clear understanding of the impact problem is to be obtained, such fundamental information as given by tension-impact stress-strain diagrams is believed to be of vital importance.

Problems Before the
ENGINEERING PROFESSION

By A. A. POTTER

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IN THE preamble to the Constitution of the American Engineering Council the definition of engineering emphasizes that engineering is the art and science of controlling and utilizing the forces of nature for the benefit of mankind.

There is, however, a growing feeling, even among the thinkers of our times that "human invention has outstripped man's organic development." Dr. Hooton at the last Annual Meeting of The American Society of Mechanical Engineers in his address, entitled "Ape to Engineer"[1] stated that civilization has advanced not because of any improvement in the mental quality in the masses within the last ten thousand years, but rather because people tolerate the engineer, who has perfected tools so that people can perform work with little or no mental effort. In one part of his address Dr. Hooton remarked:

> Man has made himself out of an ape, partly by becoming an engineer. The danger now is that the process will be reversed and the engineers will make apes of all of us. We apes shall then destroy ourselves and hoist the engineer with his own petard. . . . If man can make machines which are better than himself, cannot he make himself better?

Whether or not we fully agree with these statements of Dr. Hooton, they are a definite challenge to our creed as engineers which is supposed to stand for the improvement and not for the degradation of mankind. We engineers share in common the responsibilities and opportunities for the advancement of civilization and human welfare to which our profession has made most significant contributions in the past. As the work of the engineer affects the lives of more and more millions of people, our responsibility is to concern ourselves not only with the wealth-creating products of improved technology, but also with the human and economic problems brought about by the contributions of our profession.

MUTUAL OBJECTIVES OF ENGINEERING

Thinking individuals and progressive social groups must reflect on the past and plan for the future, must take stock of their objectives and seek improved goals. We, as engineers, must analyze our contributions, study trends, adjust ourselves to changing conditions, and take an active interest in public questions. The engineer in the past has said little about his work and has seldom concerned himself with social, economic, and political questions. He has too readily accepted responsibility for the ills of our times and has been remiss in not pointing out to the world that the engineer is primarily a creator of wealth and employment; that by proper application of science, our profession has created in the last 75 years, where nothing was before, nearly all of the major industries and utilities of today which are affording employment and careers to many millions of people.

An analysis of the mutual objectives of the engineering profession and of the instrumentalities for their accomplishment may aid us in understanding our place as engineers and as citizens in a democracy. We speak of the engineering profession. What attributes are expected of professional people? A professional man is usually considered as one professing to have acquired special knowledge, used by him in guiding, advising, or instructing others, or in serving the public through some art. He is expected to be an authority or an expert in his calling, which he gains through advanced study and experience, as contrasted from the amateur who has, ordinarily, only a superficial or elementary knowledge of the art or science he practices. Professional people are expected to extend their knowledge and skill through united effort; this is accomplished through organizations, such as national societies representing the profession. A profession has definite and standard prerequisites for admission, and licensing for practice is intended to protect these standards. A profession has a proper code of ethics and, most important, insists that its members must assume a social responsibility.

The engineer, as a professional man, must have scientific knowledge and technological skill, which he must be constantly improving by study and practice and which he must be constantly advancing through participation in the societies of his specialty. He has definite moral obligations and is expected to be guided in his personal relations to the members of his profession and the public by the code of ethics of his national society; it is more serious for the engineer to be lacking in honesty or to violate ethics of his profession than it is for him to be found wanting in specialized knowledge. Finally, the engineer has definite moral obligations for public service and is expected at all times to place human welfare and professional interests above his own interests.

Members of the engineering profession of this country have sought to provide organizations for forwarding the profession and for improving engineering practice. The backbone of the organized engineering profession is represented by the four founder engineering societies which are the A.S.C.E., A.I.M.E., A.S.M.E., and A.I.E.E. The A.I.Ch.E., while not a founder society, is closely related in its objectives to that group. Each of these major national societies is supplemented by numerous specialized societies, so that the engineering profession is being served at present by about 80 national societies in addition to about an equal number of state and local engineering organizations.

Due to the fact that each of the specialized engineering groups shares with engineers in other branches of the profession certain mutual objectives, eight functional instrumentalities have been set up, under the sponsorship of the four founder societies; these include the United Engineering Trustees, Inc., a custodian of funds for joint efforts of engineers; the Engineering Foundation, for the furtherance of research; the Division of Engineering and Industrial Research of the National Research Council; the American Standards Association, for cooperation

[1] "The Simian Basis of Human Mechanics or Ape to Engineer," by E. A. Hooton, Mechanical Engineering, January, 1938, pp. 42–46.

Presented at a meeting, Tulsa, Okla., March 28, 1938, held under the joint auspices of the Mid-Continent Section of The American Society of Mechanical Engineers and the Engineers' Club of Tulsa.

in standardization; the Engineering Societies Library; the Engineering Societies Employment Service; the Engineers' Council for Professional Development, which is concerned with the quality of the educational preparation of the engineer as well as with his personal and professional development during his early years in practice; and the American Engineering Council, which is the coordinating agency of the engineering profession intended to relate the engineer to public welfare and to government and to make our government, as well as the public at large, conscious of the value and importance of engineering services and contributions.

The organization of the National Council of State Boards of Engineering Examiners was an important factor in giving a national scope to the licensing laws for engineers and in focusing public attention upon our profession. Thirty-eight states have license laws for engineers and state registration is becoming recognized more and more as an index of engineering competency as it is as a necessary prerequisite for the practice of medicine and of law.

EDUCATION, TECHNOLOGY AND ECONOMICS, AND PUBLIC AFFAIRS

As a professional body, we must interest ourselves in engineering education. The Engineers' Council for Professional Development, through its visits of inspection and the preparation of an accredited list of engineering curricula, hopes to be helpful to our state engineering licensing boards in maintaining high educational standards as a qualification for admission to our profession, while insuring that the accredited engineering colleges of our country have sound educational programs. To an increasing extent, industries, utilities, and public works are dependent upon engineering-college graduates for the solution of their technological problems as well as those of an administrative and executive character. The curriculum of the better engineering colleges, concentrated on the underlying fundamentals, is rapidly becoming a popular type of general education, as it acquaints the student with the processes, devices, and methods that make our civilization distinctive. Cultured people are those who understand their environment, the world in which they live, and no type of education so directly assists the individual to understand his present surroundings as does engineering education. The engineer of today, and increasingly so of tomorrow, must have a thorough scientific preparation if he is to make full use of the foundations laid by science. Science and technology are interdependent, and the future progress of one depends upon the other. We must insist that those who enter our profession be capable as engineers and also that they have well-rounded ethical standards and broad interests valid in any great profession.

The engineer must have a better appreciation of the coordination of technology and economics. He must think more, write more, and talk more on social and economic matters. The engineer is not a miracle worker who can bring about through his own efforts a perfect social order, but it is felt that dealing as he does with facts rather than opinions, he should be able to make a substantial contribution to the solution of the social and economic problems that are confronting society. The engineer has a reputation for straight thinking when he deals with technological problems, and it is felt that he possesses a devotion to the truth which should prove helpful in bringing about a saner analysis of social and economic matters.

If our profession is to have its rightful share in public leadership, we must conscientiously dedicate ourselves to public service and take our rightful place in the affairs of men. Thus, another one of the major problems which is confronting our profession is that of government, as our engineering contributions to society may be lost without stable government. All over the world, the one-time free democracies are being degenerated into dictatorships or autocratic states of the communist, fascist, and nazi types. If we are unwilling to yield our freedom and our rights as Americans to a dictatorship in a totalitarian state, we must have an intelligent concern in our government and we must take an active interest in public questions. Good citizenship transcends in its importance even expertness in our profession. A member of the cabinet of the President of the United States said recently, "There is patriotism in peace as well as patriotism in war. Many of our citizens who are willing to defend their country to the death in a military emergency let down in times of peace." Government is an essential part of our existence and is today of special interest to the engineer, as the functions of government are becoming largely technological in character. Municipalities, states, and the federal government are constantly carrying on a variety of technological operations and are becoming concerned to an increasing extent with the regulation of engineering enterprises as well as with the actual operation of technical industries. The American Engineering Council is intended to aid the engineering profession in presenting a united front in matters of interest to our government and the public; it acts as a clearinghouse for questions of public nature that require technological knowledge and engineering experience and as an adviser in connection with the problems of government as they affect engineers and engineering. I am convinced that the future of our country will only be secure if the clear thinking and ablest of our citizens are willing and ready to take an active interest in public affairs.

UNIFICATION OF THE ENGINEERING PROFESSION

Finally, it is time for us to give more serious consideration to the unification of our profession in its viewpoint, thought, and action. Only through united effort will the engineering profession be able to maintain a reputation for alert impressive action, and only through such a reputation of the profession will the largest possible measure of accomplishment and satisfaction befall engineers individually.

We as engineers, irrespective of our specialty, of the college degree we hold, or of engineering-society affiliation, must assume professional status individually and collectively. We must think, act, and appear as a unified and well-coordinated group, a well-knit and well-integrated professional body, not as a collection of individuals, each going his separate way; nor can our profession be fully represented by numerous distinctive societies going their separate ways. As I have indicated in the earlier part of this talk, eight functional instrumentalities have been set up under the sponsorship of the four founder engineering societies to deal with our mutual objectives. Some members of our profession feel that engineering, like the legal profession, ought to be represented by one society. The actual fact is that the American Bar Association represents only 28,400 of the 144,065 American lawyers or less than 20 per cent. At the same time, the American Engineering Council through its 55 member societies, represents, at least 75,000 or nearly half of the engineers of this country. Considering the importance of engineering in this great industrialized land, I doubt greatly whether we could dispense with any considerable number of our technical societies or serve the engineer as well by doing away with our state and local engineering organizations. It is certain that we do not need any new society to coordinate our efforts. It is desirable, however, that greater use be made of the functional organizations, now provided, to bring about cooperation of engineering groups, and, particularly of the American Engineering Council, which was created, in 1920, with Herbert Hoover as its first president, as the functional instrumen-

(*Continued on page 571*)

WHITHER CAPITALISM?

By DOUGLAS McGREGOR

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PROFESSOR BRIEFS' choice of a title[1] for this scholarly analysis of certain trends in what he calls "the adventure of capitalism" will undoubtedly decimate his audience of potential readers. The term *proletariat* and the gospel of Karl Marx are firmly and unpleasantly wedded in the minds of many Americans. Let it be noted at the outset, therefore, that the author is not a devotee of an "un-American" social philosophy. His concern is with the problems created by the nature of the capitalistic economic system. His attitude is primarily that of the diagnostician, and his diagnosis is thorough, shrewd, and far-reaching in its implications.

The Teutonic thoroughness with which the author defines and delimits the group called the proletariat will perhaps discourage the casual reader. But perseverance will reward him with a deeper insight into contemporary conflicts. It is practically inevitable that the operation of the capitalistic system should produce a group of individuals "whose exclusive, or at least indispensable, source of income is found in the sale of (their) labor power in a shifting and insecure labor market." These are the proletarians. They are essentially propertyless, and since their income is barely sufficient to meet their immediate needs (granting that these needs may vary considerably with shifts in the socially defined standard of living), they and their children tend to remain propertyless. An historical analysis of the development of capitalism in several societies reveals the vital rôle played by the proletariat in determining the direction of this development.

The author does not commit the Marxian fallacy of assuming that the existence of a proletariat necessarily involves an antagonism toward other social groups. "It is conceivable that a proletariat might exist as a contented, well-adjusted group occupying its appointed place in the social cosmos. . . . Such a contented proletariat might very well exert itself to enlarge its social importance and improve its economic condition . . . . using none but the conventional means to this end." But he hastens to add that "this operation of fitting the proletariat into a place it can comfortably occupy in a bourgeois society has thus far not been successfully performed." The normal, unfettered operation of capitalism does not create sweetness and light for all concerned. Nor has the use of traditional means for achieving the ends of the proletariat eliminated friction. Trade-unionism, for example, while not necessarily organized on the basis of the class struggle, has not resulted in a contented proletariat.

The importance of the proletariat in a given society—its effect on the direction of social change—will depend upon the circumstances surrounding the growth of industrialism in that society, ***and upon the attitudes of the proletarians*** toward themselves, their fellows, their employers, and their government. In a brilliantly written series of chapters the author considers these causal factors in some detail. Certain attitudes of the proletarian everywhere in western civilization are a result of "the commercialization of human labor power: the fact that labor has become a market commodity and that production, socially speaking, is nothing more than a money transaction between employer and employee." Consequently, we may look for attitudes and behavior among the proletariat based on a lack of security, the suspicion of being exploited (behavior may result from the ***suspicion*** as well as from the *fact* of exploitation), the loss of pride in work, lowered feelings of social importance, and the like. Let him who has nothing but contempt for those practices of labor referred to today as "restriction of output" read carefully this chapter and ponder its implications before he allows himself the satisfaction of righteous indignation!

While this analysis of the attitudes consequent upon the operation of modern industry fulfills the demands of common sense, one cannot help a wistful hope that sociologists and social psychologists will soon carry their techniques of attitude measurement into the industrial world and bring us clear-cut quantitative evidence concerning the nature of proletarian attitudes. Even generalizations based upon such obvious premises as the author's cannot produce the conviction that would come from actual research data.

Briefs points to the importance of "the precision of performance, the punctuality, and the disciplined response which the operating of a machine and the operations of a plant alike require" in determining the proletarian's point of view. He stresses the periodic layoffs and overworking of employees associated with the business cycle and with technological advance. "It was precisely these phenomena of underdemand and overdemand that engaged the critical thought of the earliest labor organizations." Along with many other circumstances associated with the growth of capitalism, these represent the ***causes*** of "the proletarian consciousness." The author's discussion of the ***content*** of this consciousness is too detailed to be adequately summarized here, but the reviewer has rarely seen a more thought-provoking analysis than that presented in this section of the book.

We often neglect the implications of the historical fact that the proletarian movement has not everywhere taken the same direction. To understand why individuals and groups behave as they do one must take into account the underlying nature of the socioeconomic system, its history, its philosophy. Class consciousness among members of the proletariat, for example, is and has been a very different thing in Germany, in Russia, and in the United States. Here is ammunition for those who argue that "it can't happen here," but let them use it with care, for, as the author clearly indicates in later chapters, it is not easy to decide that capitalism will fare better with a continuation of the present trends in this country than has communism in Russia, or fascism in Germany and Italy.

It is nonsense, the author reminds us, "to assume that socialism represents the ***a priori*** of proletarian ideas and attitudes. Given, rather, the proletarian frame of mind, the proletarian modes of thought and valuation . . . . we have the soil on which socialism may grow provided certain other conditions which its particular nature demands are present. . . . Socialism represents a turn which the proletarian mind may take, but it is not the only one." One such turn "leads to

[1] "The Proletariat: A Challenge to Western Civilization," by Goetz A. Briefs, McGraw-Hill Book Company, Inc., New York, N. Y., 1937.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

liberalism and pure trade-unionism, another follows the course of national and Christian tradition, a third leads to socialism, a fourth to syndicalistic unionism (the I.W.W., for example), and so on. Each of these spheres of development represents a synthesis of that which is common to all proletarian groups with that which is peculiar to the group in question, namely, its outlook upon its own immediate environment and upon the larger environment of the social order." With this reminder the author turns to an analysis of three of these "syntheses," trade-unionism, socialism, and the cooperative movement.

Given the background provided by this historical discussion of the various directions which the proletarian movement has taken, the reader is prepared to perceive the American scene with considerable objectivity. Chapter 12 is devoted to a discussion of "the proletarian potential of American labor." Although the author shares with many the belief that present conditions are leading to the formation of a definite proletarian class in the United States, he indicates clearly why the American worker, whether he has owned property or not, has not in the past been characteristically possessed of "the proletarian consciousness." Particularly for those American workers from which the membership of the craft unions has been drawn, there was lacking the "endless toil and trouble, endless insecurity without a tangible chance to get beyond the scarcity line and beyond a worker's station in life." Three strata are distinguished within the structure of American labor. The first, and until recently the dominant one, is "a group enjoying a rather well-intrenched position on the labor market, be it because of skill, or favorable local and regional circumstances, or compact organizations and methods to keep them up, or whatever more or less lasting reasons." This workers' aristocracy

> ".... stamped the consciousness of American labor" with its own point of view. It "accepted the existing liberalistic and individualistic basis of society and its capitalistic form. It agreed to the equality of interests between employers and employees. The claims it made were inside claims, and as it were, partnership claims. Its occasional verbose radicalism was the radicalism of one who "speaks up." There was no class philosophy behind it.

This group of labor's élite has until recently directed and dominated the organization and articulation of labor in the United States. Through craft-unionism there has developed a mode of thinking (which the author calls paradoxically *group individualism*), a point of view directly antithetical to socialism. The latter

> .... envisages the workers' group as a whole, regarding it as an exploited class which, being victimized by those who deny it its lawful rights, has built up a social philosophy of its own, antagonistic to capital, and favorable to the idea that the means of production must be the property of all. The craft union, on the other hand, has grown out of capitalistic soil, and is prepared to fight for just one thing, namely, the largest possible share in the earnings of the enterprise in question. ... This being its main idea, it is obliged to think in terms of a special group, specifically, those who at any given time are identified with the organization. It exists, so to speak, for the insider, having no regard at all for the interests of workers in general. ...
>
> The conflicts that arise out of (craft) union activity must not then be taken as evidence of class struggle. They have to do with wage rates, hours of work, and the like—with controversial issues that arise within the system. ... There is little if any of that gnawing resentment, that bitter sense of injury and humiliation which so often marked the class conflict in Europe.

Even the bloodier conflicts between employer and employee have not been motivated by a desire to do away with the wage system. They have been attempts to gain concrete benefits "within the system" rather than through its destruction.

But a trend toward proletarization is discernible today, and it is with this trend that the last two and a half chapters are concerned. The author perceives many indications of a vital change in the American scene.

> The current phrase of social security is an indication that something substantial is being changed. ... America is turning "labor conscious," or, if we take the rural and urban middle class problems into account, "man conscious" as opposed to "business conscious." This is an expression of a great mental change: the naive belief that the economic forces solve social needs by themselves, automatically, is rapidly losing ground. This outcome of the depression and of other circumstances will not disappear. No future prosperity will doom it.

The search for security rather than for property is becoming a basic theme. The ideal of getting rich by hard work is dying a lingering death along with "the metaphysical incentive to work as a means of salvation." The recent growth of industrial unionism is seen both as a contributory factor and as evidence for this change.

Having clearly implied that "letting things alone" will not meet with the approval of the newly created proletariat in this country, the author proceeds to a more or less conventional critique of other currently proffered solutions; social-security legislation (which he believes may easily defeat its own purposes in the end), communism (which receives too little of the author's attention, perhaps), and fascism (the cost of which, in terms of individual "freedom," is vividly portrayed). By way of summary:

> Social legislation, the communist form of society, and the totalitarian state are the major approaches to the problems involved in a society where labor enjoys full citizen's rights but lacks the basis of civil freedom, namely, property. Although all these approaches are in the stage of trial and error, subject to revisions and to the heterogeneity of means and ends, this much can be said, that they at least face the issue: the adventure of capitalism consisting in the combination of freedom minus property. This problem will not disappear from the plot for decades to come. The solution which is most in line with occidental traditions and with the turn they have taken in our western civilization is social legislation in organic connection with an economic and fiscal New Deal.

But the reader who has followed the analysis will not conclude that the author has an attitude of unqualified approval toward current social legislation.

There is one chapter that could easily be omitted from the book without detracting from its value—the last one. It is definitely disappointing to the reader who has been caught up and carried along by the author's shrewd insight and wide knowledge of his subject. Unfortunately, although the keenest critics are not always the best reformers, it is considered "unconstructive" to conclude a critical analysis of things as they are without proposing a plan for things as they should be. Professor Briefs strays into a vague plea for the strengthening of the institutions of the church and the family, without making clear wherein this plea is relevant to the theme of the book. It is the reviewer's opinion that the reader will prefer to evaluate his own pet "scheme" for reform in the light of the author's analysis of things as they are and have been. The final chapter will probably not be of material assistance in this process.

With the exception of this perhaps minor objection to a fault which is by no means uniquely Professor Briefs', one can have nothing but wholehearted praise for a brilliant and scholarly treatment of a most complex and difficult set of problems. Whether he agrees with the author either in his logic or in his conclusions, the reader who is willing to invest the necessary time and energy will, upon completion of this book, feel definitely rewarded. He will not in all probability have become either more or less radical than he was initially, but he will find it difficult to be buoyantly optimistic concerning the future of capitalism. He is not unlikely also to find in himself a more tolerant regard for his fellow, the proletarian.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Day by Day

ATTENDANCE at meetings is one of the functions an editor must perform. Although one usually approaches them with some misgivings, these meetings invariably turn out to be stimulating, and even papers that have been read and reread in all stages from manuscript to page proof take on a livelier interest when they are presented by the author and are ably supported by what one always hopes will be discussion bordering on the controversial.

By the time these notes are published The American Society of Mechanical Engineers will be enjoying the hospitality of the St. Louis Section, hosts to the Society at its Semi-Annual meeting in that city, and the editor will be on a busman's holiday, in Europe, finding out if the seats in lecture halls and meeting rooms are any softer than they are in this country. Foregathering with the Newcomen Society in the English Lake District, listening to papers read at the International Engineering Congress at Glasgow, strolling about the Empire Exhibition in that city, and then dashing south to Torquay to look in at the meeting of the International Electrotechnical Commission will serve to stifle any nostalgia for engineering gatherings, and provide, it is hoped, stimulating copy for this column in the August issue. In the meantime, a few events of importance in this country deserve mention.

Morgan

Of interest to all citizens of the United States, but particularly to engineers, is the forthcoming Congressional investigation of the TVA, in which the important figure will be Arthur E. Morgan. The merits of the case involve a political controversy which MECHANICAL ENGINEERING has no intention of discussing. But it is proper to record that at least three engineering bodies, the American Engineering Council, the American Society of Civil Engineers, and the American Institute of Consulting Engineers, have passed resolutions prompted by the case.

The A.E.C. resolution, passed at its meeting of May 13, recorded "its approval of the appointment of a Joint Committee of the Congress" and stated "that the executive committee [of the A.E.C.] supports the proposal of a fact-finding investigation that shall be complete, impartial, and publicly conducted, not only to protect the public interest but to uphold the highest standards of professional engineering conduct . . . ."

Stating that Dr. Morgan had been a member of the American Society of Civil Engineers for 28 years and had served as one of its vice-presidents, the resolutions passed by that society declare its "highest respect for the personal integrity" of Dr. Morgan and urge "upon the Congressional Investigating Committee, which Dr. Morgan requested and which Congress has established, that it make a thorough investigation of such matters as he may wish to place before it and that it give full publicity to all its proceedings."

The American Institute of Consulting Engineers, in its resolutions, mentions Dr. Morgan, a member of that body, in words of high regard, expresses regret "at the terms of his removal from the chairmanship of the Tennessee Valley Authority," and states: "Resolved, that in our opinion the investigation . . . . . should be complete, thorough, and exacting in its examination, and that full public disclosure should be made of the objectives, plans, and practices which from time to time have been espoused by the Tennessee Valley Authority, and of the accomplishments which have been secured by the Authority, in the fields of flood control, navigation, electric power, land and forest conservation, and social betterment in the Tennessee Valley area."

The Joint Congressional Committee, on May 18, voted to call Arthur E. Morgan, Harcourt A. Morgan, and David Lilienthal to testify at "the earliest practicable time," and adopted a resolution making the records of TVA available to the ex-chairman for his examination and for the preparation of his case.

A.E.C

Editorial comment last month directed attention to the successful forum, first of a series to be conducted by the American Engineering Council, that was held at the Engineers' Club of Philadelphia on May 13, but this comment failed, because of lack of time, to include the gist of the discussion that was presented.

It will be recalled that discussion of the topic of the forum, "Employment and the Engineer's Relation to It," was led by Leo Wolman, economist of the National Bureau of Economic Research and professor of economics at Columbia, Leonard J. Fletcher, of the Caterpillar Tractor Company, Stephen DuBrul, economist of the General Motors Corporation, and William J. Kelly, president, Machinery and Allied Products Institute and president, Arthur J. O'Leary and Sons, Chicago. Dr. William McClellan, president, A.E.C., and member, A.S.M.E., summarized the major points made by the speakers at the conclusion of the forum, and from the May issue of *AEC Bulletin* the following report of his summary has been taken. He stated:

That Dr. Wolman had indicated that there had been a steady growth of permanent unemployment during the last 30 years throughout the countries where statistics were available and that technology was only one factor in the problem of unemployment.

That unemployment in the statistical series presented by Dr. Wolman seemed far greater in those industries which had made the least technological advance.

That governments, both in the United States and abroad, had been in business over many years, but that the social adjustments brought about by social legislation in the earlier years

had been absorbed by business and industry without great dislocation, whereas since the year 1920 there had come a period of social adjustment which had been put into effect too fast for industry to absorb it, with consequent dislocation in the more normal procedures of business recovery.

A number of speakers emphasized by practical illustration the need of "putting the pump in order" before trying to prime it. Government spending for public works was stated to be only one factor in recovery and might be a minor factor if other parts of industrial enterprise were badly out of order.

On the financial side, Mr. Kelly presented the argument that savings must be looked upon as a basis for capital improvements, that no great change can come about in the capital-goods industries without expenditures for capital goods, and that expenditures for capital goods rest upon the people's savings which make possible capital creation.

Mr. DuBrul startled his audience by stating that the labor content in man-weeks for an automobile was the same now as it was ten years ago; in other words, a Chevrolet today has the same number of labor-hours that a Buick had ten years ago, so that the labor content per dollar in a Chevrolet is the same as it was ten years ago. This apparent paradox he explained by stating that there was more in a car today relative to the quality of the car ten years ago and the difference had been made possible by technological improvements in materials, in parts, in methods, and in machinery.

All speakers agreed that the problem was complex but that there was proof that in the long run technological progress had proved the basis for increased employment. Much of the discussion of the evening revolved around other factors in the present-day situation outside of technology, including overextension of social legislation and interference with business investment on a speculative basis. It was stated that engineers shared with the other professions the need of presenting factual information to those in legislative halls, not only in the field of technology but in the related fields of economics where the work of the engineer and of the economist and the social scientist meet.

"Bible"

Having confessed to, and apologized for, a certain amount of literary filching (see page 527), we reproduce without further formality one of the "Translations from the Chinese" from Christopher Morley's page of the May 21, 1938, issue of *The Saturday Review of Literature*. Quote:

PASSAIC BIBLE

My friend the scientist said:
"I'll look it up in my Bible."
I was pleased by his unexpected piety,
Whereupon he drew out
A black liturgical volume, much tattered—
Kent's *Mechanical Engineers' Handbook*
(10th edition 1923, 153rd thousand)
Copyright by the Passaic National Bank and Trust.

The "Old Mandarin's" friend is quite definitely dated (our own copy of Kent bears the date 1909) and the tatters do credit to his reliance upon a tried and true guide that for generations has earned the affectionate nickname of "bible" among engineers. But should this scientist wish to inform himself on trends in technology that were unknown in the first postwar depression, and retire the tattered volume to a deserved rest amidst the dust of his shelves, John Wiley and Sons will be glad to sell him the two larger volumes, one devoted to power (1936) and the other to design and shop practice (1938), that constitute the bifurcated edition into which William Kent's project has developed.

Earliest of references to Kent's handbook that we have come across appears in the Transactions of The American Society of Mechanical Engineers, volume 12, 1891, in a report of the meeting at Richmond, Va., when the suggestion of the Society's undertaking the publication of a handbook was discussed. It is there recorded in a letter by Henry Binsse that a member of the Society was engaged in the preparation of such a handbook. Although no names were mentioned, none other than William Kent could have been meant.

What most impressed us, as a young man, about the older Kent was a suave urbanity that offered a perfect foil to the forthright vehemence, often carried to the point of incoherence, of Carl Barth, in arguments over so passionless a subject as machine keys. It was good fun for everybody and gave the stenographer a chance to nurse his cramped fingers, for no human or mechanical device could keep up with Taylor's slide-rule expert once he had taken the bit in his teeth on a clear track.

The other indelible impression of William Kent was the monthly post card which let the editor know that MECHANICAL ENGINEERING had been received and contained some typographical errors. The last card we remember called attention to the fact that we had used "formally" for "formerly"—quite brazenly—on the front cover.

With Kent *fils*, who now edits the engineer's "bible," association has been less formal than formerly with Kent *père*. Recently driven to the Engineers' Club because his room had been preempted by a newly arrived granddaughter, he yarned about "when I was at Sing Sing," and repeated the maxim of a Scotch uncle that the "Old Mandarin" himself would enjoy: "The man who doesn't drink whiskey until he's forty is as big a fool as the man who doesn't drink it after he's forty." And it was pleasant to learn that the latest reference in the new second volume of Kent is taken from the March, 1938, issue of MECHANICAL ENGINEERING, from a paper on the profilometer. So that's how up to date Kent is. But more about this volume will be found in a review to appear in a later issue. And by the way, that Sing Sing stuff is all quite regular. Bob Kent was Al Smith's appointee as supervisor of prison industries.

X-Ray Analysis in Industry

NATIONAL PHYSICAL LABORATORY, ENGLAND

X-RAY ANALYSES of various materials have been made in the National Physical Laboratory of the Department of Scientific and Industrial Research, England, according to the report issued for the year 1936–1937. Previous studies had shown that the electrical, magnetic, and tensile properties of a material may be considerably influenced by the state of the crystallites of the substance. Therefore, X-ray methods were developed in the laboratory with a view to determining such properties of the crystallites as their size, their degree of perfection, and their distribution in direction, all of which were found to have considerable bearing on the behavior of the material.

Following on the studies of electrodeposited nickel, in which it was shown that the hardness of the deposit was directly related to the amount of distortion in the crystallites as measured by the breadth of the lines in the X-ray pattern, examinations of chromium deposits on copper and other metals have been made. Particular attention has been devoted to the in-

vestigation of the two types of chromium deposit, one of which has a cubic structure, while in the other the atoms are arranged in a close-packed hexagonal lattice. It has been shown that the hexagonal form can be converted into the cubic by heat-treatment in the range 100 to 300 C. Under suitable conditions of current density, the deposits, both cubic and hexagonal, showed a marked fiber structure. In the hexagonal form the crystallites are so arranged that the basal plan of the hexagon is parallel to the surface, while in the cubic form the plane which occupies this position is that which is equally inclined to the three perpendicular cubic faces.

As a result of demands for observations of X-ray diffraction patterns at high temperatures, apparatus has been developed for this purpose. One form of such apparatus, designed for the study of single crystals, has been used successfully in a research carried out on the behavior of mica at high temperature. A different form of apparatus suitable for the study of metal wires, either in a vacuum or in an inert atmosphere, is being used to determine the structure of tungsten steel in the range of temperature up to 1200 C.

X-ray studies of the effect of cold work on metals have shown that the early stages of cold work are associated with a breakdown and subsequent distortion of the crystallites. The amount of this distortion can be measured by X-ray methods, since this distortion is accompanied by an increase in the breadth of the lines of the X-ray pattern. In the case of mild steel it has been shown that the structural changes resulting from the stress differed markedly according as the stress applied was greater or less than that necessary to insure ultimate fracture. A similar investigation of brass is in progress while the work has been extended to include the study of single crystals as well as of polycrystalline metals. These X-ray methods have also proved useful in dealing with problems submitted to the laboratory by manufacturers and others, particularly in connection with such materials as lead, manganese steels, and steels hardened by the nitride process.

In conjunction with the Chemical Research Laboratory, a systematic study of the corrosion products of zinc and iron has been undertaken. In the major portion of this work, electron waves rather than X rays have been used for the study of the oxide films. In the case of iron there appears to be a definite difference in the structure according as the temperature at which the film is formed is above or below 200 C. The film is not uniform but consists of different oxides occurring in a layer structure. Electron diffraction has enabled the different layers to be examined, but the full interpretation of the results is not yet available.

Ice for Air Conditioning

ICE AND REFRIGERATION

TODAY the engineer is taking air conditioning out of the novelty class and putting it into the necessity group. In a paper presented at the Second Conference on Air Conditioning, Austin, Texas, March 9–11, 1938, and printed in the April, 1938, issue of *Ice and Refrigeration*, Howard E. Degler, member, A.S.M.E., and professor of mechanical engineering at the University of Texas, points out that during the year 1937, more than $100,000,000 worth of air-conditioning equipment was sold by American companies, nearly twice the total for the year of 1936.

This increase has developed new problems for the engineer. In some cities it has become necessary to restrict the use of water for air-conditioning facilities. Wherever such conditions exist, it has been general practice to include in the system a water-conserving device, such as a cooling tower or evaporative condenser. Even in communities where there are no water-use limitations such devices are often included as a matter of economy. And then many new methods of air cooling and cleaning are being developed to decrease the initial cost and operating expenses of equipment. These include cold accumulators, evaporative cooling devices, and the use of ice for air conditioning.

Cooling with ice requires relatively inexpensive equipment consisting usually of an ice-storage tank or cabinet, a means of melting the ice with water, and a pump for forcing the chilled water through suitable coils which indirectly cool the circulated air. The use of ice for air-conditioning purposes offers a service which is superior in some respects to that obtained from other types of equipment, especially when considering costs. Undoubtedly, more ice-cooled air-conditioning systems will be installed in small business places and residences; in fact in any place where the use is of short duration and the need infrequent or uncertain.

The cooling system in the San Antonio Municipal Auditorium was recently changed from mechanical refrigeration to ice; ice-cooling equipment would have effected a large saving in the initial investment and will probably cost less to operate. Portable ice-cooled units have considerable promise for occasional use in such places as hospitals, sickrooms, and other infrequent applications. These portable units are designed to hold a charge of 100 to 300 lb of ice and contain a fan which blows the air over metal surfaces cooled by the ice.

Beryllium

INDUSTRIAL AND ENGINEERING CHEMISTRY

BERYLLIUM is to copper almost what carbon is to iron. In other words, according to an article in the May, 1938, issue of *Industrial and Engineering Chemistry*, by C. B. Sawyer and B. R. Kjellgren, beryllium alloyed with copper in quantities resembling those of carbon in iron develops properties in copper close to those in steel. As is the case with steel, beryllium copper is hardenable by appropriate and broadly analogous heat-treatment, and the tensile properties thus produced can cover a wide range, depending on the heat-treatment.

Pure beryllium metal has about the same density as magnesium but greatly exceeds both magnesium and aluminum in its melting temperature which is 1285 C. This excess of about 600 C makes beryllium, for practical purposes, the only stable light metal with a high melting point. Since this melting point is fairly close to that of iron, it is not surprising to find both the linear coefficient of expansion and the calculated Young's modulus of elasticity for beryllium close to those of iron. Beryllium may be classed with magnesium, cadmium, and zinc, since it has the same crystallographic habit and exhibits a similar degree of ductility.

Referring to the analogy of beryllium copper and steel, the authors point out an important difference. Whereas in steel, heat hardening is possible to some extent with diminishing carbon content down to 0.1 per cent, binary beryllium copper will not heat harden when the beryllium content is less than about 1 per cent. But third-metal additions, such as iron, cobalt, nickel, and chromium, have the effect of permitting heat hardening with lower beryllium contents, sometimes as small as 0.1 per cent.

In another important respect heat hardening beryllium copper differs from heat hardening steel. The hardening of both

beryllium copper and steel requires a first heating to "cherry red," followed immediately by quenching, from which ordinary steels emerge hard and brittle; but beryllium copper emerges from the quenching tank soft and ductile and capable of withstanding various cold-forming operations. It is the next step of reheating to low temperatures, which in steel tempers it, that in beryllium copper first hardens it. Continued heating or heating to a still higher temperature softens beryllium copper, just as it does steel.

The important technological fact here is that the violent initial quenching from a high temperature leaves beryllium copper in a soft workable state where it can be finished by machining, stamping, or drawing. Hardening for final physical properties is brought about by gentle soaking at a relatively low temperature. This gentle prolonged final hardening at low temperature minimizes deformation and inequalities of treatment which would result in steel, especially where the final shape is complicated.

A perfect illustration of the advantageous use of these heat-hardening properties of beryllium copper is found in a convoluted beryllium-copper bellows which forms the pressure-sensitive element of a recording subsurface oil gage developed by P. G. Exline, member, A.S.M.E. In connection with springs, there comes to the front an outstanding quality of beryllium-copper alloys—namely, high (fatigue) endurance limit. Determinations of this property in air range from over 35,000 up to 44,000 lb per sq in. and, therefore, compare favorably with the heat-treated low-carbon steels. But the unique feature of the beryllium-copper alloys is their ability to maintain their high endurance limit under conditions of corrosion and continuous exposure to temperatures of 150 to 200 C or higher.

Tensile strengths of wrought beryllium nickel copper containing 2.25 per cent beryllium may reach values of over 200,000 lb per sq in. The corresponding Brinell hardness can go to 385, and the Rockwell C hardness may reach 42. Slightly higher beryllium contents can give Brinell hardness figures in excess of 400 and Rockwell C hardness values up to 45. Good castings of beryllium copper may be made in plaster and sand molds. In this case, especially, third- or fourth-metal additions are very beneficial in preserving a small grain size.

High-Output Gas Producer

Demag News

Lignite briquets are used in a new German gas producer which is described in detail in the January, 1938, issue of *Demag News*. In order to meet changing demands, the producer can be adapted easily to a maximum as well as a minimum output. As Fig. 1 shows, besides the revolving center bottom grate, an annular grate at the base of the shaft which allows air to enter from the side. To prevent the escape of gas, water seals are provided at the top and bottom of the main shaft.

Another feature is the tubular cooling jacket, consisting of vertical D-shaped cooling tubes arranged close together and welded at their bottom ends into pairs of U-shaped elements. Each tube at its top end fits tightly into an outlet chamber which forms a ring in the center of the shaft jacket. The cooling water enters through the inlet chamber located immediately below the annular outlet chamber, runs down through the tubes, and then up the second leg of the U-shaped elements into the outlet chamber from which it flows down into the blast saturator.

The gas producer is known as a cold-gas type because the gas made in it is thoroughly cooled and washed. Since the water used to wash the gas becomes foul, it cannot be emptied into the sewers. Therefore, it is pumped through the tubular cooling jacket from which it enters and trickles down in the blast saturator *w*, which is swept by the air entering the furnace.

The water in evaporating is carried into the gas producer where it supplies just the right amount of steam required for

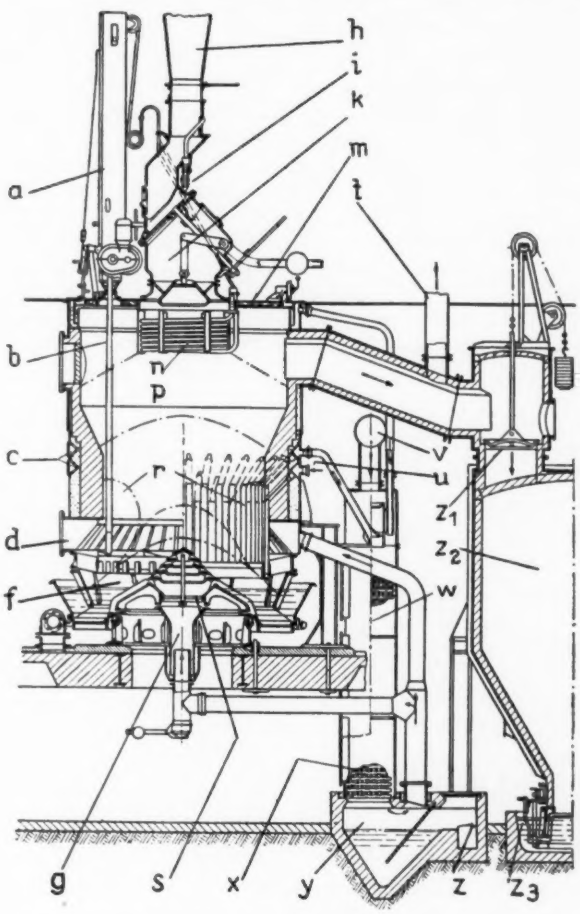

FIG. 1 SECTION THROUGH GAS PRODUCER, BLAST SATURATOR, AND DUST SEPARATOR

(a = poking apparatus; b = water-cooled poker; c = water chambers; d = air chambers; f = ash zone; g = blast zone; h = coal bunker; i = electric current and water supply; k = charging hopper; m = revolving plate; n = nest of tubes; p = carbonizing zone; r = combustion zone; s = revolving grate; t = stack; u = water supply; v = blast main; w = blast saturator; x = wooden hurdles; y = water pit; z = overflow; z_1 = gas valve; z_2 = dust separator; and z_3 = water trough with mud scraper.)

the gasification of the lignite, so that generally no foul water remains.

The approximate limits of the ash, combustion, gasifying, and carbonizing zones are indicated in Fig. 1 by the dot-dash lines. As shown, the upper part of the shaft is wider at the top which allows the charge to lie well up against the wall, thus counteracting any tendency for the fuel bed to burn away or through its edge.

Another new feature is the mechanical poker which makes possible the high gas output. The electrically operated poking apparatus, with which the charge is thoroughly loosened to let the gas through, has a withdrawable water-cooled rod which can be placed in an upright or inclined position. The revolving plate on which the poker and coal-feeding devices are mounted

is turned by the same electric motor which operates the poker. A cone or bell seal operated by a weight mechanism is used to regulate the flow of fuel from the fuel hopper into the gas producer.

The lignite briquets in entering the producer pass through a carbonizing coil, formed by a nest of tubes, in which they are heated, dried, and precarbonized, after which they pass into the main chamber. The water from the poking rod passes through the nest of tubes into the blast saturator. Then, as the coal burns, it sifts to the bottom where the ashes are removed by a plow mechanism.

The gas from the producer flows through a tank in which the dust is removed and collected in a water trough. Then it passes into two pocket precoolers, the cooling pockets of which are sprinkled on the inside with water and on the outside with tar. Here the gas is cooled indirectly and a part of the tar, particularly the thick tar, is separated. From the precoolers, the gas goes through an electrofilter where the remaining dust and tar are removed. At the final purifying stage, the light oils and water vapor left in the gas are taken out by indirectly cooling the gas to a lower temperature.

Electric Locomotives

THE INSTITUTION OF ELECTRICAL ENGINEERS

BEFORE The Institution of Electrical Engineers (Great Britain) on April 7, 1938, C. E. Fairburn read a paper entitled "The Trend of Design of Electrical Locomotives." Composed of two parts, one devoted to mechanical components and the other to electrical equipment, the paper represents the results of a comprehensive survey of technical information obtained from 10 railways in 8 countries and from 12 manufacturing companies in 5 countries, supplemented by researches in the technical press. Too comprehensive for satisfactory abstracting, the paper contains extensive tables giving salient features of the majority of important locomotives built since 1925, with excellent illustrations of five locomotives and five drives.

Attention is drawn to the growing demand for locomotives of greater power and speed, partly to meet improved running schedules and partly to avoid the higher cost of multiple operation. The outstanding feature of recent design is said to be the adoption of individual axle drive instead of side-rod drive. In general the aim of the designer has been to secure a fairly high center of gravity with the lowest possible unsprung weight on the driving axles, but recently there has been some tendency to reduce the actual maximum axle load without necessarily keeping the unsprung weight low or maintaining a high center of gravity.

Recent years reveal no appreciable tendency to increase the horsepower transmitted through a set of gears, but to increase the running speeds of gears. Metallurgical improvements have been used more to secure longer life than to increase tooth loading. Helical gears are not widely used.

For low-speed units the double-truck locomotive without carrying axles is largely used; for high speed carrying axles are invariably used. Most railways use air-operated brakes and only one with a considerable number of locomotives—the Spanish Northern—has retained vacuum brakes. Tired wheels are used in European practice, but in North America, where tractive efforts per wheel are high, solid wheels are used wherever possible. About half the locomotives designed during recent years have roller bearings on the motor armatures, but in only a few instances are they fitted to the axle boxes also. Except in America, where the cast-steel frame predominates, the built-up plate type of main frame and truck frame is practically universal. Welding has been applied with success to the construction of locomotive bodies. As most electric locomotives are operated at moderate speeds only, streamlining has not made any great progress, and most designers appear to have aimed at securing an attractive appearance by partial streamlining—special decorative schemes to accentuate horizontal lines, and rounded surfaces, rather than introducing streamlining as a purely technical improvement.

Making Night Driving Safe

ENGINEERING NEWS-RECORD

A RECENT talk by R. W. Crum, director of the Highway Research Board, pointed out that if night driving could be made as safe as daytime driving, highway accidents would be reduced by one third and almost half of the lives lost might be saved. Therefore it is interesting to note an article in *Engineering News-Record* for April 14, 1938, describing the installation of plastic reflectors along an 85-mile stretch of highway from Detroit to Lansing, Michigan, as a step forward by engineers for making night driving safe.

The new reflectors are made of Lucite methyl methacrylate, a plastic that is water-clear, flexible, and nonshattering. This plastic molds much more accurately than glass, retains permanent transparency, does not change color, and remains stable in service over a long period. The reflectors are set 100 ft apart on either side of the roadway, except at curves where they are slightly closer. The headlights from an automobile makes it possible, as they are thrown on the reflectors, to outline the highway a mile ahead.

The plastic reflectors are designed according to an optical principle known as retrodirective reflection. Of the two practical types of retrodirective reflectors, the one used is the triple reflector or cube corner. It is effective because of a very high degree of accuracy built into the cube corners making up the back of the reflector disks. No silver or metallic surfaces are used because the cube corners themselves, although transparent are nonetheless perfect prismatic reflectors.

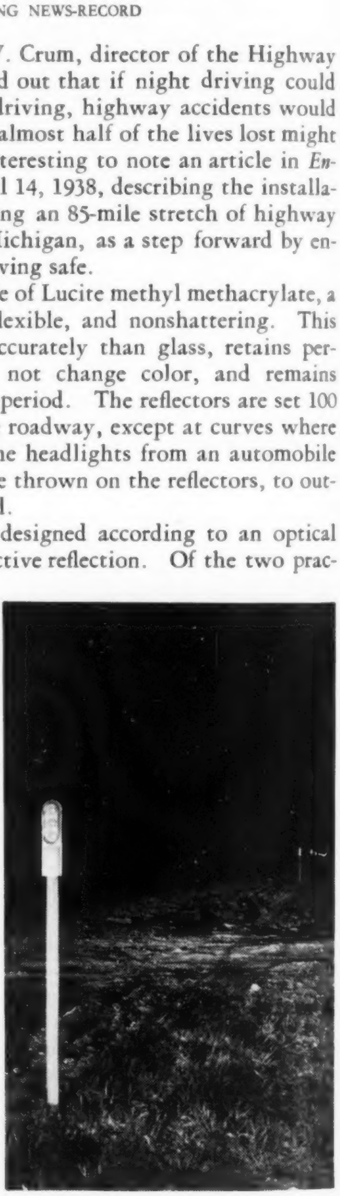

FIG. 2 NEW PLASTIC REFLECTORS USED FOR OUTLINING HIGHWAY AT NIGHT

Another aid for the night driver is the luminous type of highway center traffic line which has been noticed in recent months on highways in New Jersey, Massachusetts, and Long Island. It is thousands of times brighter at night than the white and yellow lines ordinarily used. It consists of two elements; a liquid binder compound of any color and glass spheres approximately 0.015 in. in diameter embedded in the binder. This reflecting material, applied the same as ordinary paint, reflects the rays from a car's headlight

and produces a luminous guide line for the driver, brilliant at night, in fog, or even when facing the strong headlights of approaching cars.

Production of Malleable Iron

AMERICAN FOUNDRYMEN'S ASSOCIATION

IMPROVEMENTS in the manufacture of steel castings have limited the field of the commercial application of malleable-iron castings, but recent great developments in malleable iron and its production have enabled it to extend its field to castings of small size, where moderate tensile strength, low ductility, and slight bending are required. It has the advantage over steel of better resistance to shocks within the limit of its strength. Further improvements in the production of malleable iron are discussed in two papers scheduled for presentation at the annual meeting of the American Foundrymen's Association in Cleveland, May 16–19; "Production of Short-Cycle Malleable Iron," by W. D. McMillan, and "Design of Straightening Equipment for Malleable-Iron Castings," by C. W. Weedfall. Summaries of the papers follow.

In his paper, McMillan tells how pearlitic malleable iron, in which either cementite or pearlite or both are retained, is being produced in cycles of approximately 6 hr. Until recently 60 or 70 hr have been required to produce a full anneal, that is, a structure consisting only of ferrite and temper carbon. Today, iron of the conventional analysis, 1.00 per cent silicon and 2.50 per cent carbon, is being annealed in 30 hr. The iron discussed in the paper has been annealed in 14 hr and 28 min, the resulting structure reflecting a full anneal with retention of no cementite or pearlite.

The two factors which operate to shorten the annealing time are the higher silicon content, which promotes graphitization, and the higher percentage of net metal in the annealing furnace made possible by the elimination of heavy pots. The equipment for annealing the short-cycle iron is a gas-fired, radiant-tube, pusher-type furnace, containing three rows of trays and five zones of heat. The iron reaches a temperature of 1700 F in about 3 hr and is held at that temperature for about $2^1/_2$ hr. It is cooled to 1475 F in 2 hr by air which is forced through tubes in the roof and floor of the furnace. Then it is cooled to 1200 F in about 6 hr and further reduced in temperature in the fifth zone by cooling tubes to facilitate handling; the second fast-cool period being about 1 hr. Scale is prevented by the use of an atmosphere which is forced into the furnace, thus maintaining a slight pressure in the furnace. The atmosphere is produced from 800-Btu gas by partial combustion and dehydration. The equipment has operated on less than 2 cu ft of 800-Btu gas per net pound of castings including the gas required for the atmosphere.

This type of iron shows a tensile strength of 55,000 to 60,000 lb per sq in. with an elongation of 15 to 20 per cent. The yield point is approximately 44,000 lb per sq in. Because this metal offers several advantages, among them higher tensile strength, higher yield point, and lower ultimate cost, principally because of a lower annealing cost and quicker delivery of castings, it is thought that there should be interest in its application to castings other than the relatively light section parts.

Discussing straightening equipment for malleable-iron castings, Weedfall shows how warpage is caused by the relief of internal strains in the casting when it is heated to the high temperatures used in the annealing process. When a casting cools in a mold, internal strains are produced. These strains result from unequal cooling of the various sections making up a casting and from the resistance of shrinkage, due to the shape of mold and cores used. Deformity in annealed castings can be lessened to a considerable extent by packing hard iron castings tightly in sand or some other inert material which acts as a support for the casting so that it can withstand the strains that produce deformity. This method cannot be depended upon to produce accurate castings, and, in most cases, straightening equipment still must be used to produce a uniform product.

To straighten a casting which has become warped or deformed during annealing requires the application of a blow or pressure sufficient to bend it back to its original shape and produce a permanent set in the metal so that it will retain this shape. Such a force, used in straightening malleable castings, has little effect upon the structure of the metal. The different types of straightening equipment discussed in the paper are straightening fixtures, forming dies, squeeze dies, and hammer dies. Factors affecting the design of these various equipments are outlined under their respective headings.

Straightening fixtures are hand-operated devices, consisting of cast or machined blocks conforming with the shape or contour of castings to be straightened, and with or without clamping means to assure positive locating points. Hand hammers are used as the straightening medium.

Forming dies consist of a top and lower die made up of stationary parts. The lower die is placed on the bed of a press, while the top die is secured to the ram. The top and lower dies open and close with the ram movement and usually are held in relation with one another by guide pins. The purpose of the forming die is to distribute the vertical force of a press into direct or resulting angular forces upon the surface of a casting that is straightened.

Squeeze dies consist of a top and lower die, either or both of which are made up of a number of movable wedge-shaped parts. These parts are machined in relation with one another to form a cavity. The sides of this cavity, which come in contact with a casting, straighten the casting when the die is closed. Springs usually are used to hold these wedge-shaped pieces apart to provide clearance for loading and unloading the die. Actuating and holding means are provided to keep the moving parts in relation with one another so that the entire die can operate as a self-contained unit.

Drop hammers are used chiefly for striking dies, although some squeeze dies have been used successfully. Hammer dies must be built stronger and of better material than press dies, and parts must be held together more securely, as the force of the blow tends to loosen them. Drop hammers have a short cycle of operation and are considered fast, providing they do satisfactory straightening with one strike or blow. When hammers apply more than one blow on a casting, they may be considered to have straightening power in proportion to the number of blows used. In such a case speed of operation is sacrificed for power.

Motion Study

ST. LOUIS MEETING, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PROPER allowances for variation in material and for changes in methods of operation are much more important than accuracy of timing in motion study, according to A. B. Segur, member, A.S.M.E., in a paper presented by him at the Semi-Annual Meeting of The American Society of Mechanical Engineers in St. Louis, June 21, 1938. He claims that some time-study engineers are so foolish as to buy stopwatches which make a revolution in three seconds in the belief

that their studies will be more accurate. Others go so far as to use motion-picture machines to obtain accuracy. According to Segur, more attention should be paid to motion simplification. An abstract of his paper follows:

Drawing on his personal experiences, he cites several cases and from them observes that the real problem in establishing a wage-incentive plan is to discover the right method of doing the job, and in this way the question of rate setting becomes very simple. Some people think that motion study can only be applied to highly repetitive jobs. Nothing could be further from the truth. A punch press or drill press may not be utilized for more than eight jobs in one day. A foundry molder may make only one or two molds from one pattern. All that is necessary in such cases is to make an analysis of the machine or work station to ascertain the conditions which should be present and then set up a rate plan which will make it essential for the man to follow the correct method if he is going to make out on rates.

The most important qualification of the industrial engineer installing the new plan is an ability to properly instruct the

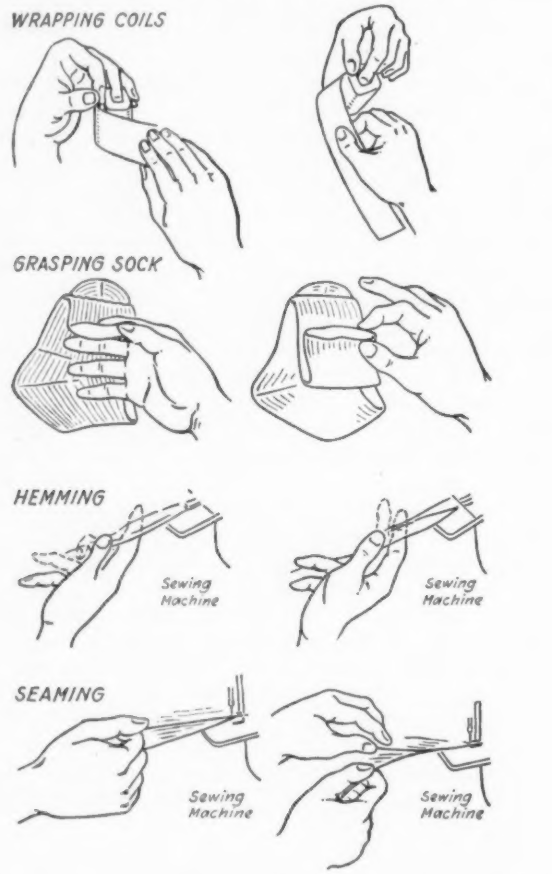

FIG. 3 NEW AND OLD METHODS OF PERFORMING VARIOUS OPERATIONS

foremen and operators in the new methods. A proper motion study of any job will not only show savings of 15 to 75 per cent but will make it unnecessary in the future to lower the original time allowance or to cut rates. Operations which formerly required a training period of two years can now be learned in two weeks with a higher degree of efficiency. Furthermore, wide differences in speed between operators are avoided, because with this type of training all tend to become expert at their tasks. But most important of all, the wage-payment curves are straight lines with this plan of control.

Some of the motions studied and improved by the author are described and illustrated. A slight difference in the method of holding coils for wrapping increased the speed of the work by 220 per cent. By using the new method, shown in Fig. 3, operators had no trouble in wrapping 4200 coils per day as compared with a total of 1900 per day with the old method. The best output with the old method of picking up a sock for the boarding operation was 100 pairs a day as compared with an average of 160 pairs per day after motion study and training. In hemming on a sewing machine, a slight difference in holding the cloth increased hemming speed from 50 to 200 in. per min. In seaming, holding the cloth between the top of the thumb and the joint of the index finger enabled the operator to seam from 200 to 400 in. per min. With the old method of holding the cloth between the tips of the index fingers of the two hands, the speed was only 50 in. per min.

Standards of Living

THE ATLANTIC MONTHLY

RETURNING from a recent trip to Europe, Gerard Swope assembled some notes on his observations on relative standards of living in the United States and eight other countries which will be found in the *Atlantic Monthly* for March, 1938. Comparisons on the basis of currencies being out of the question, Mr. Swope has based his on the length of time an average workman, in certain industries, would have to work for such as rent, food, common luxuries, electric energy, and an incandescent lamp. Briefly, he reports the following comparisons (lows and highs refer to the eight countries abroad):

Percentage of year's income to pay year's rent, low 18, high 33, U. S. 18; number of hours' work required to purchase a unit of five food items, low 4.25, high 7.3, U. S. 1.7; number of months' work required to purchase an electric refrigerator, low 2.4, high 7.3, U. S. 1.0; number of months' work required to purchase a radio set, low 0.4, high 1.5, U. S. 0.2; number of minutes' work required to purchase one kilowatthour of energy, low 12, high 43, U. S. 3.6; number of hours' work required to purchase an incandescent lamp, low 1.2, high 3.4, U. S. 0.2.

Maybe we have something after all!

Streamlined Management

PEORIA SECTION, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

TO KEEP any business synchronized with modern trends and requirements, its management must be streamlined, according to a paper by T. S. McEwan, chairman of the Chicago Section, A.S.M.E., presented before the Peoria Section of the Society, Jan. 20, 1938. Streamlining an enterprise, in other words, signifies the organization, coordination, guidance, and control of all the activities of the business, executive, production, and sales divisions, to produce results commensurate with available opportunities.

In developing his subject, Mr. McEwan cites the various fundamentals necessary for effective management control, illustrating some with actual cases, and concludes with a check list of questions for management. A brief outline of the stated fundamentals is contained in the following abstract.

The underlying indispensable factor which must be present in any business for its successful administration is sound leadership. Sound leadership inspires confidence and produces

action. The real leader, be he the president, general manager, or chairman of the board, is always sensitively alert to the trend of the times, ever watchful for the progress of his company, and long-visioned. It is his job to coordinate the work of the departments of his business and streamline the aggregate effort to achieve the ultimate objectives of every phase of the enterprise, namely, net profit, and the good will of employees and the public.

The next important fundamental is a well-worked-out organization procedure which involves the establishment of definite duties and functions, exact delegation of authority, and guidance of personnel. It insures proper shaping of policy and administrative control of all activities. The next step is to secure men capable of manning it. Naturally, the very best man in the world for each position cannot be secured, but a streamlined organization can always develop raw material into real executives through a training program which gives the ambitious junior executives and new employees an opportunity for self-improvement and advancement. A proper training and promotion program coupled with a method of advising on progress makes for satisfied personnel.

Proper accounting, statistical, and office methods and routines permit the measurement of the performance of the enterprise. Usable records supplying information opportunely for control purposes, not merely as history, are of paramount importance, especially when confined to those of real use, excluding any of only temporary or personal curiosity value. Budgets are necessary. Any variances between actual and budgeted amounts must be reported promptly so that immediate remedial action can be taken.

What constitutes a fair day's work? Will past performance serve as a yardstick? Progress is too rapid these days for any concern to be content with simply equaling or beating past performance. Every worker in the organization, from office boy to president, wants to give a good account of himself. The measurement of effort and the setting of a goal serve to call forth the best response from each.

Standard costs covering every division of activity are necessary because they indicate required performance rather than recording past history. Probably in no other function is there so great an opportunity in any organization for the development of a scientific knowledge leading to greater profits. In the same way that streamlined management tries to make production operations automatically repetitive, so it endeavors to make value manipulators create values automatically and repetitively. These value manipulators are known as incentive systems. In certain exceptional cases, nonfinancial incentives have brought out extra effort. However, money is the usual tangible reward for successful achievement. This requires not guessing or favoritism, but a scientifically devised wage-incentive plan.

In this day and age of rapidly changing styles and radical improvements in design, a concern must be constantly on the alert to keep the utility and appearance of its products up to date. Increased eye appeal, new packaging, and easy handiness, are necessary for the company to stay in the favored front position of the industry.

To obtain the best results from the physical equipment requires: (1) An exact knowledge of the latest designs of available machinery and tools, possible savings, and the limitations involved; (2) optimum machine activity and best flow of work through the plant; (3) preventive maintenance to keep up standards of performance and eliminate breakdowns; and (4) a well-planned arrangement of plant and equipment to eliminate bottlenecks and achieve maximum performance.

A streamlined organization must have a far-sighted financial policy to insure its smooth-running and stable operation. Care should be taken to coordinate sales effort with finance and production. A streamlined management takes a great interest in the production end of the business, particularly waste elimination, maintenance, power, tools, order department, and the stockroom. The matter of time study, job analysis, standardization of methods, production planning, scheduling, routing, economic-lot manufacturing, and a well-organized internal transportation system, are also considered.

Today, streamlined management recognizes that proper employer-employee relations provide the only hope of any degree of peace between administration and worker. The present-day workman desires a living wage and feels that he is an important part of the cooperative activity. Foremen's clubs, employee-representation plans, and evaluation of base rates, help to establish a better feeling in industry and commerce.

In any organization plan, management must not neglect or overlook the importance of research, which is a systematic investigation on the various frontiers of business operation whereby the best results, commensurate with available opportunities, are obtained. Its proper field is the business as a whole, including management, motivation, man power, materials, finance, manufacturing, machinery, methods, maintenance, and merchandising. Research is a moving force that keeps a concern forging ahead, gives a high ratio of return on the investment, and justifies its cost as insurance against an enterprise falling into a state of innocuous desuetude.

Finally, an enterprise, no matter how streamlined its management, cannot hope to enjoy a long and successful life unless the whole industry is healthy. An industry in which concerns use such practices as wholesale price-cutting, selling below costs (often due to lack of information on costs), secret rebates, and other unsound trade activities, is doomed to suffer and, possibly, to succumb to decay and replacement.

Problems Before Engineering Profession

(Continued from page 561)

tality of our profession, to aid the engineer in presenting a united front in matters of interest to the public and to our government.

I am in full accord with the views of some leaders of our profession who feel that our influence depends upon our ability for concerted action and upon a strong group influence on the course of government as it affects engineering. Recent years have witnessed major social, economic, and political changes which are greatly affecting the engineer and his work. Some of the plans now under way in an effort to mold our future, to remedy present ills, may result in retarding technological advance, which is greatly influenced by opportunities for individual initiative and freedom from directive laws. It is only by united action that engineers can best serve the public as well as our profession.

If we, as engineers, are to enhance our past accomplishments and insure a brighter future for the members of our profession, we must assume a greater social responsibility by taking a keener interest in social welfare and economic readjustment; we must insist on higher ethical standards and better educational preparation as prerequisites for admission to our profession; we must interest ourselves in politics and make our contributions to good government as citizens of a democracy; we must extend our professional knowledge through united action; and we must work for greater unity and better solidarity among engineers.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Planning Railroad-Equipment Purchases

To the Editor:

The report of the President's railroad committee sent by him to Congress for legislative action on the reorganization of railroads contains the following statement:

> It is significant that 19,773 locomotives, representing 74.1 per cent of all freight locomotives, are more than 17 years old. In other words, nearly three fourths of the entire number of locomotives are more than 17 years old, costing more to maintain and operate than would modern power which might well replace at least 50 per cent of the units. . . .

and, further:

> it would seem reasonable that approximately 40 per cent of existing freight equipment could be replaced with modern units to the advantage of both the public and the carriers.

The Interstate Commerce Commission's "Annual Report on the Statistics of Railways in the United States for the Year Ended Dec. 31, 1936," the last available, mentions that on that date there were in service 1,813,837 freight cars. Therefore, if the recommendations of the committee were to be carried out, 9886 freight locomotives and 725,000 freight cars would have to be replaced. Moreover, in addition to, and concurrently with, the freight-locomotive replacement program, a high percentage of the 5452 passenger, 710 freight or passenger, and 6227 switching locomotives, built before 1920 and still in service on December 31, 1936, would have to be replaced. This would bring the total number of locomotives to be replaced in the near future to about 16,000. The question arises, can such a vast program be completed within a reasonable number of years, while retaining the present, somewhat haphazard methods applied by the railroads in acquiring new equipment?

It is a well-known fact that volume of orders for motive power and rolling stock fluctuates widely from year to year. An analysis shows that that equipment buying scarcely ever anticipates a business boom and growing needs of traffic caused by it. On the contrary, orders are usually placed when the boom, and, in consequence, prices and wages have reached, or at least are near, a peak. The following tables serve to illustrate these remarks.

The annual report on railway statistics for 1936 gives the number of locomotives according to the year in which originally built, excluding switching and terminal companies, as follows:

1920	1146	1929	686
1921	720	1930	731
1922	840	1931	132
1923	2878	1932	36
1924	1314	1933	1
1925	826	1934	60
1926	1362	1935	36
1927	795	1936	66
1928	371		

Similar conditions apply to freight cars, as shown in the following table taken from the same source. The number of new freight cars installed in the years 1932 to 1936, inclusive, was:

1932	2815
1933	1936
1934	23948
1935	6987
1936	37554

According to the first table, in the 17 years since 1920 a total of 12,000 locomotives have been bought by the steam railways, and 2914 of this number were installed in the decade from 1927 to 1936. At the average rate of replacement which has taken place in these 10 years, it would require about 50 years to carry out the locomotive replacement program. Even at the average rate of replacement for the 17 years from 1920 to 1936, about 23 years would be needed for this purpose. The freight-car situation, though somewhat more favorable, is similar.

The prevailing unsatisfactory equipment situation which might lead to a serious shortage of motive power and rolling stock in case of increased traffic to be expected as a result of an upturn in business, or, what God forbid, a national emergency, cannot be ascribed entirely to the chronic financial plight from which many railroad companies are suffering. Even companies with impaired credit have been able to market their equipment trust certificates at reasonable interest rates. Its main cause might be sought in the absence of any guiding plan, for the railroad industry as a whole, for the systematic replacement of obsolete equipment, the high maintenance and operating costs of which would economically justify its retirement. The buying is actually done by scores of individual managements which cannot possibly be expected to make their decisions from the viewpoint of the railroad industry as a whole and of the public interest.

However valid may be the reasons for the lag in replacement, past experience has shown conclusively that the problem of systematic modernization of motive power and rolling stock is insoluble without the aid of some central agency to deal with it in an orderly, well-planned manner. The word "planning" has recently acquired a somewhat ominous meaning, but there is no reason for discarding a good thing because it has been ill-used. In this case planned, long-range action seems to offer the shortest and safest way out of a situation which is affecting adversely the efficiency and earning power of the railroads.

The modernization of equipment is only a minor, though very important phase of the broader problem of railroad reorganization. In consequence, the type of organization of an agency for planning and unifying the purchase of railroad equipment, the extent of its functions, and the method of financing must, of course, depend on the character of the intended railroad reorganization, now before Congress. But whatever form this reorganization might finally take, it is difficult to conceive how, without such an agency, could be achieved anything even approximating the recommended and necessary replacement program.

The advantages to be expected from its systematic realization are obvious and manifold:

(1) An inventory of modern locomotives and cars adequate to meet at all times the demands of a changing volume of traffic, in particular in case of a national emergency.

(2) A saving in maintenance costs which increase rapidly with the age of equipment.

(3) A saving in operating costs, due

to greater efficiency and lower fuel consumption of modern locomotives and the lower weight of cars of welded construction and built of alloy steel.

(4) A saving in first cost of new equipment, due to the reduction in overhead and manufacturing costs because of an even flow of orders over a number of years.

(5) Stabilization of the railroad-equipment industry which in its best postwar year, 1923, turned out products valued at about 728 millions of dollars and employed an average of more than 110,000 wage earners.

(6) Stimulation of industries supplying materials, machinery, and tools, to the equipment industry.

(7) Stimulation of business in general, due to sustained buying power of the employees of the equipment and auxiliary industries.

Moreover, under a system of unified buying of equipment it would be possible to set aside annually certain amounts for testing new inventions, developments, and manufacturing methods which might be beneficial to the whole railroad industry, thus distributing the risk individual railroad companies might be reluctant to assume. There can be no doubt that such an undertaking would serve as an encouragement and powerful stimulus to progress in the field of railroad-equipment engineering.

H. R. TAUBE.[1]

Forestry Civilian Engineers

TO THE EDITOR:

The letter on CCC training and reserve officers that appeared in the April issue[2] entirely omits any reference to the engineers of the Forestry personnel who are attached to each camp and have the working period of the boys entirely under their control. In camp, the reserve officers are in charge of camp maintenance, quarters, and complete sustenance, with the necessary Army paper work.

Having been intimately connected with CCC camps and knowing the many miles of road that were built and the numerous bridges and buildings that were constructed from the designs of and under the supervision of the Forestry Civilian Engineers, I can commend their work to prospective employers and nature-loving friends. In particular, I have in mind camps S-56 and S-58 which were located on Licking Creek in Rothrock Forest near Mount Union, Pa. This forest covers about 100,000 acres; contains 80 miles of roads; abounds in deer, beaver, and other forms of wild life; and has two fire towers from which magnificent views of the surrounding territory can be obtained.

ROBERT LACY.[3]

[1] New York, N. Y. Mem. A.S.M.E.

[2] "CCC Duty Is Engineering Experience," by Marion B. Richardson, MECHANICAL ENGINEERING, April, 1938, pp. 342-343.

[3] Shade Gap, Pa. Mem. A.S.M.E.

Question of the Day

TO THE EDITOR:

I am very much interested in the editorial, "Question of the Day" in the May issue of MECHANICAL ENGINEERING.

It seems to me strange indeed that scientists and engineers for the most part seem to show little, if any, inclination to follow the clear lead of research and investigation when applied to economics. When it comes to most other subjects they seem to be quite willing to discard any theories or practices which a careful investigation seems to indicate are wrong, but with economics they seem quite willing to try over and over again theories which will not even hold water as theories and have been exploded through many trials extending back for centuries.

To give one example: Price fixing and control by governments has been tried and found to be a flat failure as far back as we have any history and there is not the slightest indication that it ever can be successful—still we go on making fresh trials.

Now there is no reason for believing that mathematics is founded on any more fixed laws than is economics. What is the hope of having equitable working conditions between so-called management, the public, employees, etc., when government denies the birthright of all its citizens and proceeds to tax away almost every incentive to industry and progress.

When, and if, enough people come to realize that there is no need for any taxes whatever and that all society or the government needs to do is to collect the value of that which it creates as society, then we will have equitable conditions under which everyone can work and be entitled to what he produces without its being taken from him in taxes.

The power to tax has been said to be the power to destroy. If then we must tax, let it be applied to things we do not want and let those which we do want be tax-free. Certainly what we do not want is lost opportunity to work natural resources.

I advise a careful reading of Henry George's "Progress and Poverty." That book written in 1879 depicts our present situation so clearly that one might think it was written last year. It points the way so unmistakably on which we must go for any permanent recovery, that it is sad indeed it does not get more attention.

The danger of communism or fascism is not from outside but from within and if we do not get our house in order we shall have it and for the same reason some other countries now have it. The populace will not permanently submit to a denial of their birthright and the consequent uncertainty and poverty of many of their number.

If we stop wasting time on "trends" under present chaotic conditions and get down to the simple A B C's, we will get somewhere in a hurry and beat the dictators to it. "The one best way" is to follow the simple clear-cut natural laws of economics.

THEO. H. MILLER.[4]

Radiographic Inspection

TO THE EDITOR:

The author, Mr. Isenburger, in his paper Radiographic Inspection,[5] is certainly correct in saying that one of the greatest aids to the introduction of fusion welding for important work has been the development of nondestructive methods of testing.

Radiographing was the turning point in the development of sound and reliable welding and remains a most useful tool in the industry. All welded joints cannot, however, be radiographed and the question arises as to how far one should go in requiring this to be done.

The A.S.M.E. Boiler Code requires the main joints of the drums of power boilers and of unfired pressure vessels for hazardous services to be radiographed. Nozzle connections may, however, be fusion-welded to the same vessels without radiographic examination. In ship construction it would be impracticable to radiograph the joints and the use of fusion welding is nevertheless growing apace in this industry. The same holds in the manufacture of many other parts that are now joined by fusion welding.

Radiographing is regularly employed by some manufacturers as a check in securing sound welding even though it may not be called for by a construction code covering the work. It is useful in

[4] Works Manager, De Laval Separator Company, Poughkeepsie, N. Y. Mem. A.S.M.E.

[5] "Radiographic Inspection," by H. R. Isenburger, MECHANICAL ENGINEERING, November, 1937, pp. 809-812.

checking up welding operators when their work is questioned. It is generally conceded to be an invaluable aid in securing the highest type of construction as called for in the A.S.M.E. Boiler Code and in other cases, such as in the welded joints of large penstocks. While its merits are beyond question, there are certain welds where practice has advanced without its use.

It is the consensus of opinion that circumferential joints in the ordinary sizes of power piping need not be radiographed. The Code for Pressure Piping of the American Standards Association does not require the joints to be radiographed or tested by any method other than that sample joints shall meet certain physical tests.

The A.S.M.E. Power Boiler Code allows steam pipe not exceeding 14 in. inside diameter which is not in contact with the furnace gases to be fusion-welded without radiographic examination, but rigid qualification tests are required for the process and for the welding operators.

A number of authorities in marine construction are cooperating in preparing rules under the American Welding Society for the fusion welding of piping for marine use. As has been pointed out on a number of occasions, the hazard in marine steam piping is probably greater than in any other class of service. Those working on the rules appreciate this feature. In a tentative code which will be published in the *Journal* of the American Welding Society for the purpose of eliciting discussion the welded joints are not required to be radiographed, provided they are inspected by the paramagnetic-powder method.

Considering all of the evidence before us, Mr. Corey is certainly correct in his conclusion[6] that X-ray examination of the welded joints in question should not be made mandatory.

O. R. Carpenter,[7] who has had extended experience in radiographing in field-weld inspection, holds the following views:

> The application of X rays to field work has been retarded because of the lack of suitable equipment. The writer has on several occasions used equipment, similar to that described in Mr. Isenburger's paper, in the field. The positioning of such X-ray equipment (which includes a 150-lb tube and case, long heavy high-tension leads, and a bulky heavy power plant) at the locations of field welds distributed throughout the circulating and feeder system of a boiler, for example, is difficult and at times impossible. No more portable X-ray apparatus than the present portable tube types has been devised and its uses for radiographic examination involves an expense at times in excess of the cost of welding and assembling the joint.
>
> Radium offers an easy solution to the objection of unportability of X-ray equipment. Mr. Isenburger makes mention of the use of radium for this purpose in his article, but stipulates that he does not prefer its use on wall thicknesses under $1^1/_2$ in. The reasons cited are the lack of contrast and detail due to the short wave length of gamma rays. The writer has during the past year taken more than 60 pipe welds ranging from $^3/_4$ in. to $1^1/_2$ in. thick with gamma rays. The capsule containing the radium salt or emanation gas may be placed on the inside of the pipe and the X-ray films around the outside of the weld. If the pipe is large enough, the capsule may be placed at the center of the girth weld with rays emanating in all directions from this central source, and the entire weld may be exposed with a single setting. For small-diameter pipe it is necessary to offset the capsule from this central position to provide a reasonable focal distance from capsule to film, and a number of exposures are necessary for a joint. Exposure time will vary with the strength of the available radium salt or emanation gas, with the thickness of the weld, and with the focal distance employed. With 100 mg of radium salt and for normal pipe sizes, exposures will generally be from 5 to 15 min.
>
> In a recent case field welds were radiographed with radium using a 100-mg capsule. The radiographs of welds in 8-in. and $10^7/_8$-in. OD pipe were taken in three exposures of from 5 to 8 min, covering one third of the circumference in each exposure; the wall thicknesses were $^7/_8$ in. and 1 in., respectively. The welds in 16-in. and 20.4-in. OD pipe were taken in one exposure, with the radium at the center and the films covering the complete circumference. The shell thicknesses were $1^1/_4$ in. and $1^1/_2$ in. respectively, and the times of exposure 15 and 20 min.

While the use of radium may be preferable to the X ray in certain cases, as brought out by Mr. Carpenter, this would not warrant making its use mandatory for conditions where practice has demonstrated the reliability of the welding without a radiographic examination.

D. S. JACOBUS.[8]

TO THE EDITOR:

The author greatly appreciates Dr. Jacobus' comments. It is our business to point out important applications of radiography, but it is up to the engineers to determine whether a hundred per cent inspection is justified in each case.

Dr. Jacobus has mentioned welding of marine piping. It is the writer's understanding that two U. S. Navy Yards, Philadelphia and Brooklyn, will soon install portable X-ray equipment for that purpose, despite the fact that the Navy Department has large quantities of radium available

In other countries, more so than in the United States, X-ray inspection has been used for the examination of other types of welded structures. Particularly in Germany, X-ray inspection is a great inspection tool for what they consider important structures. The State Railroads now make X-ray inspection mandatory in their welding specifications after they have had years of experience in field work (1).[9] In France the all-welded plate girder railroad bridge of Plaine-Saint-Denis near Paris was X-rayed last year (2). A very important application is the examination of welded fuselage structures in airplanes. Practically all European airplane manufacturers have been equipped with X-ray machines for a good many years. Some of the more recent experience has been described by Schmidt (3). In marine construction, European navy yards are well-equipped with X-ray units. One of the first was the Navy Yard at Copenhagen. A few years later Wilhelmshaven followed with a large portable X-ray installation (4).

Much information concerning the practical experience with magnetic-powder methods for weld inspection can be found in a series of reports from the Reich's X-ray laboratory (5). They also discuss the American experience with this inspection tool. It is generally accepted that below about $^1/_8$ in. from the surface, defects cannot be detected in that way. This would make this method useful on thin pipe only and even then an X-ray picture should be made to show the nature of the actual defect. Thus defects near the root of the welded seams in pressure piping would not show up with paramagnetic powder.

The author was especially interested in Mr. Carpenter's remarks concerning the use of radium for field-weld inspection, but regrets that he failed to indicate the quality of his results. In our experience the most serious defects in welded seams, namely lack of fusion and cracks, will not show up in a gammagraph. We, therefore, do not recommend its use for such work. Our experience checks with that of other independent workers in this field. The sensitivity of X-ray and gamma-ray methods as shown in Table 1 has been determined by Dr. Berthold (6)

[6] MECHANICAL ENGINEERING, March, 1938, pp. 258–259.

[7] Research and Development Engineer, The Babcock and Wilcox Company, Barberton, Ohio.

[8] Advisory Engineer, Babcock & Wilcox Co., New York, N. Y. Past-President, A.S.M.E.

[9] Numbers in parentheses refer to the Bibliography at the end of this letter.

and agrees with the findings of Dr. Pullin (7) and the writer's experience.

TABLE 1

Thickness of steel.......	30 mm	50 mm	70 mm	100 mm
Detectable defect with:				
X rays.....	0.2 mm	0.5 mm	1 mm	2.5 mm
Gamma rays	1 mm	1.7 mm	2.2 mm	3.5 mm

This means that on thicknesses below four inches of steel, defects smaller than three per cent of the total thickness cannot be detected by means of gamma rays. Dr. Pullin goes so far as to state that "X rays have overwhelming advantages in the examination of metallic structures up to a thickness of about 3 inches." Although radium has been used for the inspection of welded seams in this country, the author does not know of any recent literature on this subject. All our own results were negative.

Mr. Carpenter states in part: "No more portable X-ray apparatus than the present portable-tube types has been devised." This is a statement of fact which is incorrect and misleading. We are using in practical work and have been using for two years equipment which goes everywhere the welder goes. Our X-ray tube weighs about 100 lb and the shield is only 30 in. long, whereas Mr. Carpenter's insert tube alone is 40 in. long. Other features of this tube and our compact unit have been described in the original paper and in more detail elsewhere (8).

Since the original article was written more than ten months ago, we have had some additional experience which may be of interest. In one case which was reported to have required about 25 per cent repair, the second unit was welded by the same welders. Due to their previous training under X-ray control, these welders had perfected their technique to such an extent that they were able to turn out perfectly sound and acceptable joints. Consequently, X-ray inspection could be discontinued. Again on another job which was done by crack welders, still quite a few welds needed repair.

The more experience we have and the more welding jobs we see, the more we are convinced that X-ray inspection is not only a valuable aid but a necessary tool. At present, it is the only method of inspection that will give one hundred per cent results on welded pipe joints. We would prefer not to examine the joints at all rather than use methods which give misleading results even under ideal conditions.

H. R. ISENBURGER.[10]

[10] President, St. John X-Ray Service, Inc., Long Island City, N. Y.

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2 "Le Controle des Soudures d'un Pont Sous Rails en Charpente Métallique Entièrement Soudée," by P. Widman and R. Schmidt, *Le Génie Civil*, May 15, 1937, pp. 440–443.

3 "Controle non destructif des assemblages tubulaires soudes utilises en construction aeronautique," by Petiniaud and Schmidt, *Aeronautique*, vol. 19, 1937, pp. 3–8.

4 "Röntgentechnische Prüfung von Gusstücken auf der Marinewerft," by E. Schatzmann, *Stahl und Eisen*, vol. 53, 1933, pp. 539–541.

5 "Neue technische Hilfsmittel Magnetpulver-Prüfung," by Wilhelm and Schirp, *Mitteilungen des Vereinigung der grosskesselbesitzer*, vol. 65, 1937, p. 369; Ibid, Magnetpulver-Prüfung in U. S. A. by R. Berthold, pp. 370–371.

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7 "Radium in Engineering Practice," by V. E. Pullin, Proceedings of The Institution of Mechanical Engineers, vol. 124, 1933, pp. 305–332.

8 "X-Ray Tubes for Industry," by H. R. Isenburger, *Electronics*, January, 1938, p. 20.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of April 29, 1938, which were subsequently approved by the Council.

CASE No. 808 (Reopened)

(*Interpretation of Par. H-24*)

Inquiry: a May the provisions of Par. P-216 be applied to heating boilers as an extension of the provisions of Par. H-24?

b In the case of welded low-pressure heating boilers operating at not over 15 lb steam and 30 lb water, having unflanged heads, may the provisions of Par. H-24 be applied? If not, what would the requirements be with respect to the area to be stayed and what would be the maximum height of the segment above the tubes?

Reply: a The provisions of Par. P-216 may be applied to the design of low-pressure heating boilers having flanged heads.

b Excepting only the allowance of 2 in. above the tubes, the provisions of Par. H-24 may not be applied to the unflanged flat heads of welded heating boilers. For unflanged flat heads in low-pressure heating boilers operating at not over 15 lb steam and 30 lb water, attached to the shell by any of the methods shown in Fig. 31, staying is not required if the height of the segment between the edge of tube hole and the underside of shell does not exceed $1.25p$.

For unflanged flat heads in low-pressure heating boilers operating at not over 15 lb steam and 30 lb water, attached to the shell by (*b*) and (*c*) methods shown in Fig. 31, staying is not required if the height of the segment between the edge of the tube hole and the underside of the shell does not exceed $1.25p$. If the method shown in (*a*) of Fig. 31 is employed, $1.5p$ may be used.

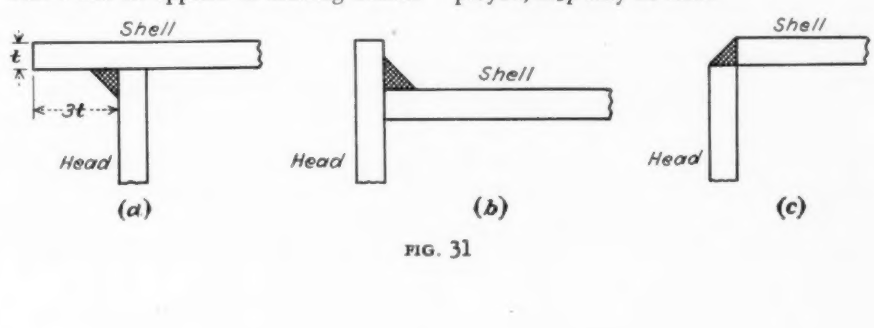


FIG. 31

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Inventions and Their Protection

Inventions and Their Protection. By George V. Woodling. The Penton Publishing Company, Cleveland, Ohio. Cloth, 6 × 9 in., 326 pp., 47 figs., \$5.

Reviewed by H. H. Snelling[1]

SHOULD "Inventions and Their Protection" be rewritten with a more logical order of topic sequence and with the deletion of the ill-chosen remarks concerning "intension" and the unpalatable assumption that Satan invented Eve and secured a patent on her over the Creator's patent on Adam, this reviewer would praise the book highly because of the author's happy faculty of presenting technical thoughts clearly, accurately, and readably.

Chapters 1 to 8 are written with a skill above the average and give to an engineer or executive helpful advice concerning the proper approach to patent problems based upon a wide range of conditions that frequently arise in connection with the main question, which is: Should my idea be patented? Interesting matters written with a simplicity that masks the scope of their presentation include such diverse points as the company's rights in an employee's invention, confidential disclosures, the collecting of company files of patent copies relating to narrow fields of endeavor, and the ever-increasing right or interest of the general public as affecting patents or employment contracts.

Chapters 9 and 10 are entirely out of place in the same book with the preceding ones, which beyond any doubt were written at a different time and for a different class of readers. The excellent suggestions in the first eight chapters can be digested by any engineer without any legal training, whereas any mere inventor who would attempt to handle his own application through an interference proceeding, would as readily undertake a surgical operation, and probably as successfully.

Chapter 11 comes back to earth again and presents the essentials of a patent application with the same clarity that characterizes the first eight chapters. From the millions of patents available, a better example could have been selected, however, and this would have eliminated the palpable error that Switzerland is a state having counties.

Chapter 12 contains 41 pages and covers a most important subject, the value of the claims of a patent. Parts of this chapter are good; other parts, topic 166, are more confusing than helpful, while still other parts are worse, topic 151, "Example of Adam and Eve." After taking the reader over the high hurdles of interferences including two pages of testimony, the author chooses a living creature as an invention rather than a wheelbarrow, naively explaining:

> An actual mechanical device has not been chosen because of the possibility that the reader might not be familiar with its construction and operation.

Except for this atrocious choice and the useless excursion into extension and intension, leading to the presentation of a needless rule on page 263 that has been proved inaccurate on page 220, the subject matter of this chapter is well handled and there is no doubt that the author not only knows his subject but also has the ability to express his thoughts with directness. Frequently, some of one's own lost cases cause an author engaged in the active practice of patent law to have a biased view on a controversial question that later will become well-settled law, but Mr. Woodling is quite free of this tendency, the nearest approach to error being the suggestion that, in design patents, "one claim is generally sufficient" whereas, only one claim is ever permitted, according to Rule 82(*c*) of the United States Patent Office.

Chapter 13, dealing with infringement and its avoidance, is well written and should be helpful to inventors and their employers. The author may be correct about the three-legged stool but, at least, a possibility exists that our highest court, as now constituted, might hold that a four-legged stool works upon a different principle and would not infringe. A safer example could have been found.

The three closing chapters are quite brief, discussing design patents, assignments, and trademarks. The omission of the word "not" at the top of page 310 is an obvious editorial error as so few typographical errors in the book can be found.

Inasmuch as there is so much helpful information in the book not available elsewhere in such a simple and direct manner and primarily because all the advice is so clearly presented that it would be difficult to misunderstand the author, purchase of the book is recommended to those of the engineering profession who are interested in inventions and their protection.

[1] Snelling & Hendricks, Washington, D. C. Mem. A.S.M.E.

Hell on Ice

Hell on Ice: The Saga of the "Jeannette." By Commander Edward Ellsberg. Dodd, Mead & Co., New York, 1938. Cloth, $5^3/_4 \times 8^1/_2$ in., 421 pp., \$2.75.

Reviewed by H. G. Bowen[2]

IN "Hell on Ice" Commander Ellsberg presents a vivid recital of the *Jeannette* expedition and the subsequent search for DeLong as he imagines Admiral Melville would tell the story.

Commander Ellsberg was not only logical to an extreme in selecting Melville for his mouthpiece but he was also thoroughly aware that he was selecting the most dramatic and outstanding member of the expedition. Melville started in early to exhibit those traits which we always associate with his name.

On the night of October 5, 1864, the famous Confederate commerce destroyer *Florida* entered the harbor of Bahia, Brazil, and anchored. The Union screw sloop *Wachusett*, nine guns, 1032 tons, was already lying at anchor there operating under orders from the Navy Department to intercept Confederate cruisers. The *Florida* carried a battery of two 7-in. rifles and six 6-in. guns.

Captain Collins of the *Wachusett* formally challenged the captain of the *Florida* to battle outside the three-mile limit but to no avail.

The *Florida* had received permission to

[2] Rear-Admiral, U. S. N., Engineer in Chief, and Chief of the Bureau of Engineering, U. S. N., Washington, D. C.

remain in port for 48 hours and Captain Collins determined to destroy or capture the *Florida* before the time limit expired, international law or no international law. It was obvious that the method employed must be the one which offered the most prospects of success. A council of war was held; Melville suggested ramming and this method was selected. To certain objections, Melville replied, "I do not think the boilers will break loose; but, if they do, there need be but one man sacrificed, for after the engines are started, I can work them alone, and will order all hands on deck." Melville was then 23 years of age and we can begin "to get his number." He actually went out to the *Florida* in civilian clothes by shore boat, went up the gangway, sized up her armament and the location of her machinery, before the officer of the deck hustled him over the side.

The *Wachusett* got under way and rammed the *Florida* on the starboard side abaft the beam, cutting her down for 18 in. below the water line, carrying away her mainyard and mizzen mast, throwing her afterbroadside gun down the cabin hatch, and burying her ship's company below the awnings, which were forced down on them by the wreckage. The *Florida* was promptly boarded by the *Wachusett* and captured, and towed out of the harbor. At the time of the ramming Melville was entirely alone down below except for the presence of fireman Bradley who refused to leave him.

It is perfectly obvious from "Hell on Ice" that Melville's ingenuity and intrepidity kept the *Jeannette* afloat long after she might have succumbed with a less resourceful and indomitable individual on board. But until Melville bids farewell to DeLong in that tragic passage down the open water of the Arctic Sea, we are dealing with Melville the subordinate; after that farewell, with Melville the general officer.

Melville's whole conduct in the Lena Delta was splendid. Think what it meant in his enfeebled condition to start the search for DeLong.

"To the southward, toward Yakutsk, whither he had ordered Danenhower to proceed, a warmer sun was shining, and there lay the great Russian road leading to the borders of civilization; to the railway, to the blue sea, to home! Few men, after passing through all the perils that Melville had survived, would have thrown away that seeming last chance of personal safety; but he, being cast in rare heroic mold, turned his back upon the means of saving himself and set his rugged face to the northward, forcing his way into the darkness and the awful silence of the Arctic winter like one deliberately invading the dominions of death."[3]

One can never forget when the natives mutinied, saying "We have no food. We cannot go. We shall die!" and when Melville replied: "I will go on. We shall eat the dogs first; and after that, I will, if necessary, eat you Yakuts; but I will go on!" and they went!

In 1887 Secretary of the Navy Wm. C. Whitney, impressed by the rate of expansion of the Navy and the magnitude of the engineering problems connected therewith, decided that the existing vacancy as chief of the Bureau of Engineering must be filled by an engineer of great executive ability, vision, judgment, and force. Accordingly, he went well down the list of junior chief engineers and selected Geo. W. Melville, influenced chiefly, it is said, by Melville's record during the cruise of the *Jeannette*.

As chief of the Bureau of Engineering and engineer in chief of the Navy, it didn't take him long to get under way. He put vertical, inverted main engines of short stroke and high speed in the *Maine*, he pioneered watertube boilers, and boiler testing for fuel consumption. He was always fighting for more speed. The fast cruisers *New York*, *Brooklyn*, *Columbia*, and *Minneapolis* attest to this fact as well as the increasing speed of the battle line. He was responsible for the creation of the Fuel Oil Board, the standardized screw method of ship trials, the Engineering Experiment Station at Annapolis, and postgraduate education in engineering in the Navy. As early as 1903 he was advocating the installation of turbines in one vessel of the Navy for experimental purposes.

[3] Bennett's "The Steam Navy of the U. S."

In marine engineering, he was a progressive of the right kind and against those who were satisfied with the old order, and those who were opposed to progress, he fought the same battles as all progressives from time immemorial.

During Melville's tour of duty as chief of the Bureau of Engineering and engineer in chief of the Navy, from 1887 to 1903, a new Navy was built aggregating a million and a quarter horsepower.

In breathing the breath of life into the memory of the noble DeLong and the indomitable Melville, Commander Ellsberg has performed a public service.

[EDITOR'S NOTE: Admiral George Wallace Melville, president of The American Society of Mechanical Engineers in 1899, was elected an honorary member of the Society in 1910. He died in 1912, and, in 1914, the Melville Medal was established by his bequest.]

Books Received in Library

DIESEL, DER MENSCH, DAS WERK, DAS SCHICKSAL. By E. Diesel. Hanseatische Verlagsanstalt, Hamburg, 1937. Cloth, 5 × 9 in., 491 pp., illus., 7.50 rm. This first comprehensive biography of Diesel has been written by his son. His ancestry and early life, work and inventions, and periods of despair and of success are described, together with an account of his travels, including the last trip by boat, from which he so strangely disappeared.

DIESEL OPERATORS' MANUAL. By J. W. Anderson. McGraw-Hill Book Co., Inc., New York and London, 1938. Leather, 5 × 8 in., 263 pp., illus., diagrs., charts, tables, $2.50. A concise, comprehensive book that treats its subject from the viewpoint of safety. It supplements the manuals of the engine builders by explaining in everyday language the matters that must be attended to, the reasons why, and the appropriate methods.

ELECTRON AND NUCLEAR PHYSICS. By J. B. Hoag. Second edition. D. Van Nostrand Co., New York, 1938. Cloth, 6 × 9 in., 502 pp., diagrs., charts, tables, $4. A presentation of the experimental evidence for those concepts which lie in the domain of electron and nuclear physics. Many basic relations and experimental techniques are common to several fields of study, hence the large amount of material covering experimental facts and physical principles of the newer as well as the longer-known concepts. The first section concerns the characteristics and emission of electrons; the second, nuclear phenomena including transmutations; and the third, laboratory technique. Descriptive experiments are included with each chapter.

ESSENTIALS OF ENGINEERING MATHEMATICS. By J. P. Ballantine. Prentice-Hall, Inc., New York, 1938. Cloth, 6 × 9 in., 502 pp., diagrs., charts, tables, $3.75. A unified treatment of mathematics has been used in this practical introduction to the calculus. Differential and integral calculus are considered side by side with those parts of analytic geometry, trigonometry, and college algebra that seem logically connected with or dependent on the calculus. Problems and logarithmic and trigonometric tables are included. Certain new features, such as the rigorous treatment of integrals as antidifferentials, are incorporated in the presentation.

GROSSE INGENIEURE, LEBENSBESCHREIBUNGEN AUS DER GESCHICHTE DER TECHNIK. By C. Matschoss. J. F. Lehmanns Verlag, Munich and Berlin, 1937. Cloth, 6 × 9 in., 334 pp., illus., 8.40 rm. (6.30 rm in U. S. A.) Short biographies of a number of great engineers from all periods of historical time, the information concerning mainly their lives rather than their technical work. The first section includes men of antiquity to the time of the decline of Rome; the second covers the middle ages and renaissance to the industrial revolution, including mostly Germans; the last, beginning with James Watt, ends with Oskar von Miller (Deutsches Museum) and is concerned mainly with mechanical engineers.

GRUNDLAGEN FÜR DIE MESSUNG VON STIRNRÄDERN. By G. Berndt. Julius Springer, Berlin, 1938. Paper, 6 × 10 in., 155 pp., diagrs., charts, tables, 16.80 rm. The measurement of involute toothed gears is the subject of this treatise. Following the determination of the ideal gear wheel, come methods for measuring contact angles and tooth flanks. The determination of flank shape, tooth slope, and circular division of gear wheels is covered, and the effect of the impulse blows of the teeth on the running of the gear is considered. Testing and inspection methods are included.

HANDBUCH DER METALLBEIZEREI, NICHTEISENMETALLE. By O. Vogel. Verlag Chemie, Berlin, 1938. Cloth, 8 × 11 in., 262 pp., illus., diagrs., charts, tables, 22 rm. (16.50 rm in U. S. A.) This interesting and valuable work claims to be the first comprehensive monograph upon the pickling of nonferrous metals. Upon the basis of a careful survey of the scattered literature and with the assistance of a number of experienced engineers, an account of the development of pickling processes and of the equipment and operation of modern plants is provided. Part one considers the development of the art, plant design and equipment, the disposal of spent liquors, hygiene, dangers to health, first aid, and accident prevention. Part two describes practical methods of preliminary cleaning and of pickling the various commercial nonferrous metals.

HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1938. Vol. 16. American Society of Heating and Ventilating Engineers, New York, 1938. Leather, 6 × 9 in., 1188 pp., illus., diagrs., charts, tables, $5. This valuable reference book is compiled by a committee of the American Society of Heating and Ventilating Engineers to provide the technical data needed by designers and constructors of heating, ventilating, and air-conditioning systems in convenient, usable form. The new edition has been carefully revised, especially in the chapters dealing with air conditioning, and a new chapter on air conditioning in the treatment of disease has been added. In addition, the volume includes a collection of data from manufacturers' catalogs, an index of equipment manufacturers, and the membership list of the Society.

INTERNAL-COMBUSTION ENGINES. By H. E. Degler. John Wiley & Sons, New York, 1938. Cloth, 6 × 9 in., 411 pp., illus., diagrs., charts, tables, $4. A further contribution to the literature in the field, this book includes the customary material on fuels and combustion, design and operative information for various types of engines, engine details, and testing methods. Special attention is paid to gas engines and high-speed Diesel engines, owing to their increasing importance.

LATEX AND RUBBER DERIVATIVES AND THEIR INDUSTRIAL APPLICATIONS, A BIBLIOGRAPHY OF PATENTS AND PUBLISHED LITERATURE, June, 1932–January, 1937. Vol. 2 and vol. 3. By F. Marchionna. *The Rubber Age*, New York, 1937. Cloth, 6 × 9 in., 1670 pp., tables, $20, not sold separately. In 1933, Mr. Marchionna published a valuable annotated bibliography upon "Latex and Its Industrial Applications," which reviewed the literature and patents prior to June, 1932. The present volumes form a supplement bringing the subject down to January, 1937, and also covering earlier references omitted from the first volume. The scope of the work has been extended to include rubber derivatives. In all, the supplement contains over 2900 abstracts of patents and periodical articles, carefully classified and provided with name and subject indexes. Those interested in the investigation or use of rubber will find the work a valuable guide.

MITTEILUNGEN DES WÖHLER-INSTITUTS, BRAUNSCHWEIG, Heft 32. Friedr. Vieweg & Son, Braunschweig, 1938. Paper, 6 × 8 in. 76 pp., illus., diagrs., charts, tables, 4 rm. The major part of this communication consists of a long article on the behavior of elastic couplings in continuous operation, particularly with respect to the determination of damping. Following a tabular presentation of the couplings to be examined, comes the description of the torsion tests, including installation and apparatus, as applied to the various couplings. Two short articles on natural elastic constants and surface cracks appear at the end.

MODERN METHODS OF REFINING LUBRICATING OILS. (American Chemical Society Monograph Series No. 76.) By V. A. Kalichevsky. Reinhold Publishing Corp., New York, 1938. Cloth, 6 × 9 in., 235 pp., illus., diagrs., charts, tables, $6. The object of this book is to systematize and clarify the information available on modern methods of refining lubricating oils. General principles only are considered, together with the description of commercially applied solvent processes for dewaxing and deasphalting oils. The use of additives for improving the viscosity index, depressing the pour point, and altering other particular characteristics is also discussed. Each chapter has a bibliography.

NEW HORIZONS IN PLANNING. Proceedings of the National Planning Conference, June 1–3, 1937. American Society of Planning Officials, Chicago, 1937. Cloth, 6 × 9 in., 178 pp., $2. Proceedings of the National Planning Conference for 1937, in which four national planning organizations participated, containing a collection of papers covering various phases of city, metropolitan, county, state, regional, and national planning.

DAS RICHTEN DER GESCHÜTZE. By C. Waninger and P. Füsgen. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 70 pp., illus., diagrs., charts, tables, 6.50 rm. A discussion of the aiming of artillery, particularly with respect to the matter of compensating for nonlevel emplacements, either fixed as on land or moving as on ships. The ensuing errors are shown and the means by which they can be avoided are demonstrated.

SCIENCE AND MUSIC. By Sir J. Jeans. The Macmillan Co., New York, 1937. Cloth, 6 × 9 in., 258 pp., illus., diagrs., charts, tables, $2.75. Music from the viewpoint of physics is the subject of this somewhat unusual book. The physical explanation is given for various phases of the art, such as sound representation by curves, sounds produced by stretched strings and by air columns, harmony, scales, acoustics, and the physiological interpretation of sound.

SPEZIFISCHE WÄRME ENTHALPIE, ENTROPIE UND DISSOZIATION TECHNISHER GASE. By E. Justi. Julius Springer, Berlin, 1938. Cloth, 7 × 10 in., 157 pp., illus., diagrs., charts, tables, 19.80 rm. In recent years, static thermodynamics has developed to a point where the specific heat, enthalpy, and entropy of gases in the ideal state can be calculated from spectroscopic data with greater exactitude than that obtainable by direct measurement. This monograph deals with the practical application of the method. The author first discusses the conversion of caloric data from the ideal to the real state of a gas and then deals with the static calculation of the caloric data of gases in relation to temperature. A final section discusses the phenomena attending the dissociation of gases. Results are tabulated for most of the technically important gases.

SYMPOSIUM ON SIGNIFICANCE OF TESTS OF COAL. American Society for Testing Materials, Phila., 1937. Paper, 6 × 9 in., 132 pp., illus., charts, tables, $1. $0.75 to A.S.T.M. members. Six papers concerning various types of test of coal, with respect to their significance and value in its utilization. Discussion by men other than the authors are included.

THOMAS' REGISTER OF AMERICAN MANUFACTURES, 28th edition, 1938. Thomas Publishing Co., New York. Cloth, 9 × 14 in., illus, $10 to old subscribers, $15 to new subscribers. This huge annual compilation of American manufacturers has its customary three main sections: The classified directory of products (with index) in which the firms are listed with a capital rating, geographically under each product; the alphabetical list of manufacturers, giving addresses, subsidiaries, branches, and similar information; and the trade-name index. A new adjunct, of use to purchasing agents, is the arbitrary number given to each advertiser, which numbers, with their corresponding companies, are listed in a separate "key" index.

VDI-FORSCHUNGSHEFT 388, ZEICHNERISCHE BEHANDLUNG VON KRÄFTEN UND MOMENTEN IN KOPPEL- UND RÄDERTRIEBEN. By A. Budnick. V.D.I. Verlag, Berlin, 1938. Paper, 8 × 12 in., 22 pp., diagrs., charts, tables, 1.50 rm. A description of a graphic treatment of the forces and moments in coupled and gear transmissions. The use of moment planes of mechanisms and lineages is explained, with special references to the determination of equilibria and frictional losses.

WASSERKRAFTANLAGEN. (Handbibliothek für Bauingenieure, edited by R. Otzen.) By A. Ludin. Second half, First Part, Talsperren, by F. Tölke. J. Springer, Berlin, 1938. Cloth, 7 × 10 in., 734 pp., illus., diagrams, charts, tables, 78 rm. This volume, which forms part of an unusually comprehensive work on hydraulic power plants, is concerned with the design and construction of large dams. The first section discusses general matters, such as the economic problems, the hydrological conditions and the geological and geotechnical investigations of dam sites. Section two, upon dam types, describes current types of earth and masonry dams, with detailed data upon design. Section three discusses the construction of concrete dams. Section four is devoted to the study of stress distribution by means of models. The final section discusses the relative safety and economy of the different types. The book is profusely illustrated.

WERKSTATTBÜCHER, Heft 64, edited by H. Haake. METALLOGRAPHIE, Grundlagen und Anwendungen, by O. Mies. Julius Springer, Berlin, 1937. Paper, 6 × 9 in., 64 pp., illus., diagrams, charts, tables, 2 rm. A concise presentation of the fundamentals of metallography intended as an introduction to the subject for engineers engaged in practical work. The relations between the structure of the metals and their properties as materials are emphasized.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. Fall Meeting to Be Held at Providence, R. I., Oct. 5–7

F. S. Blackall, Jr., General Chairman of Committee Handling Details of Technical Sessions, Excursions, and Entertainment

WHILE the program for the A.S.M.E. Fall Meeting at Providence, R. I., October 5 to 7, is still in the formative state, it is not too soon to say that the technical sessions give promise of an extremely valuable group of papers. Sessions are being planned by the Fuels, Power, Iron and Steel, Machine-Shop Practice, Management, Process Industries, and Textile Divisions.

Jewelry-Manufacturing Industry

It seems particularly appropriate that one of the management sessions is to be devoted to a symposium of the management problems of the medium- and low-priced jewelry manufacturing industry since it is said that three fourths of the employees engaged in the jewelry-manufacturing industry in the United States are employed within a radius of 20 miles from Providence.

The industry is unique in that it has no large companies but many small ones, each engaged in a highly specialized line. With the general interest in the decentralization of industry, a discussion of the management problems in this field seems most appropriate.

Fuels and Power

High-pressure installations, circular and intertubular burners for large-capacity pulverized-coal-fired boilers, industrial power-plant steam and power generators, oil burners for domestic heaters, condenser-tube problems, slime and algae control, and evaporator application are all to be covered in the sessions on fuels and power.

Machine-Shop Practice

The machine-shop practice sessions are to have papers on thread-grinding, ground surfaces, precision boring, electric controls and drives, die-casting design, climb hobbing applied to cutting gears, arc welding, plastic-mold design, and manufacture.

Iron and Steel, Process, Textiles

Of special interest in the iron and steel sessions are papers on magnaflux inspection applied to aircraft-engine parts and developments in powder metallurgy.

A symposium on rubber and plastics covering an engineering history of rubber, synthetic substances with rubber-like properties, and the fabrication of rubber products will interest those of the process group, while the textile-minded will have sessions on cotton and worsted spinning, weaving, drying, and finishing.

And that is an array of papers if we ever saw one—a technical-session preview.

Clambake Promised

The days will not be altogether technical, however, for plans are being laid for excursions and trips to interest everybody. An old-fashioned clambake is planned for one evening to take the place of the usual banquet. If you have been to a real clambake we need not tell you about it, and if you haven't been, we wouldn't be able to do it justice. A clambake—in Rhode Island—is simply not to be trifled with.

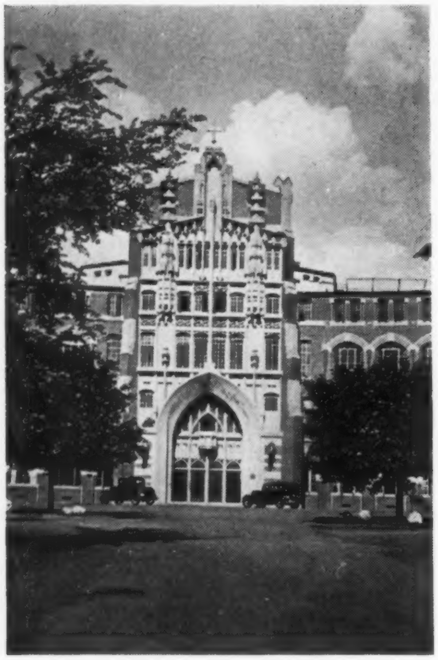
Providence

Providence is an old city—one of the oldest of the English settlements in this country. It was founded in 1636 by Roger Williams on a charter, which for the first time, proclaimed the doctrine of noninterference in the religious beliefs of the people of the state. The successors of this great pioneer built its trading and industrial achievements, surviving today.

For quaintness of its colonial section, the richness of its historic sites and architectural triumphs, its museums and institutions of higher learning, Providence offers a variety of interests.

It was at Brown University in 1790 that George Washington received the degree of LL.D. and during the Revolutionary War, American and visiting French troops were for a time quartered in University Hall, erected in 1770. On the middle campus is the John Carter Brown Library of "Americana," the most valuable library of its kind in America, which must be consulted by every first-hand investigator into the history of North and South America. A block from the John Carter Brown Library is the Annmary Brown Memorial, containing paintings by eminent masters of all countries; a collection of printing and wood engraving dating back to the fifteenth century, superior to any similar collection in America; and a long list of priceless family relics. The John Hay Memorial Library, named in honor of the last Secretary of State who was an alumnus of Brown, faces the campus of the University. This splendid marble building contains over 215,000 volumes, including the Harris collection of American poetry, and one of the finest of Dante collections.

UNIVERSITY HALL, ONE OF OLDEST COLLEGE BUILDINGS IN AMERICA, FACES THE FRONT CAMPUS AT BROWN UNIVERSITY IN PROVIDENCE



HARKINS HALL, PROVIDENCE COLLEGE

St. Dunstan's College of Sacred Music, Rhode Island School of Design, Providence College, and Pembroke College—in connection with Brown University—are other institutions of high rank located in Providence.

Rhode Island State College, an important and rapidly growing educational institution, is located at Kingston, about 30 miles from Providence, and is well worth a visit.

For those who are spending just a short time in Providence, there is much to be seen within easy riding distance. Newport, distinguished for more than 100 years as a city of beautiful homes, has bathing beaches of rare distinction and a beautiful drive along the shore line, and is the base for various departments of the U. S. Navy. It is from Newport that one goes out to sea to follow the International Yacht Races. Across the bay from Newport is Narragansett Pier which is distinguished for one of the four famous bathing beaches in the world. To the south is Westerly from which one proceeds to such beauty spots as Watch Hill, Misquamicut, and Weekapaug; and all the way up the shore through Wakefield, Wickford, and East Greenwich, there is a delightful variety of small resorts which are attractive and hospitable stopping places.

Headquarters for the Meeting will be the Providence Biltmore Hotel on City Hall Square. Other near-by and well-known hotels are the New Crown, the Narragansett, and the Dreyfus.

Committees

A meeting does not just handle itself and much hard work is done by Committee members. On the General Committee for the Providence Fall meeting are:

Frederick S. Blackall, Jr., *General Chairman*

J. G. Aldrich	N. D. MacLeod
Z. R. Bliss	E. C. Mayo
W. S. Brown	A. W. Meyer
A. W. Calder, Jr.	C. T. Morey
A. C. Chick	A. W. Moulder
F. A. Chiffelle	R. T. Ode
W. C. Dart	J. D. Robinson
J. D. Eldert	H. D. Sharpe
E. W. Freeman	C. J. Simeon
F. C. Freeman	H. S. Sizer
H. T. Freeman	S. A. Vaule
W. H. Kenerson	W. A. Viall
W. A. Kennedy	L. E. Wagner
P. N. Kistler	R. L. Wales
Morell MacKenzie	E. L. Wilson

Chairmen of subcommittees follow: Mrs. Clarke Freeman, Chairman of Ladies' Committee; Prof. Zenas R. Bliss, Chairman of Technical Events Committee; Wendell S. Brown, Chairman of Printing and Sign Committee; John D. Eldert, Chairman of Plant Trips and Transportation Committee; Prof. W. H. Kenerson, Chairman of Reception Committee; Wm. A. Kennedy, Chairman of Information and Registration Committee; Prof. Paul N. Kistler, Chairman of Hotel Committee; Norman D. MacLeod, Chairman of Entertainment Committee; Chester T. Morey, Chairman of Local Finance Committee; and Laurence E. Wagner, Chairman of Publicity Committee.

Professional Divisions Committee Passes New Rules on Presentation of Papers at Meetings

L. K. Sillcox Replaces Crosby Field as Chairman of Standing Committee

MEETING in the Engineering Societies Building on May 18, the Standing Committee on Profession Divisions, with Crosby Field presiding as chairman, considered ways and means of facilitating the receipt of papers for national meetings. After discussion, the following motion was passed:

Voted: That for all meetings subsequent to the St. Louis Meeting, papers not received within the date specified, either by the Executive Committee of the professional division or by any other proper receiving agency for the Society, be considered as not to be placed on the program of that meeting and not to be announced in any publication of the Society carrying the program of the meeting. Papers must be in the hands of the Executive Committee of the professional division or in the Secretary's office by the final date set by the Standing Committee on Professional Divisions. The Society staff shall notify the Committee, 15 days before the dead-line date, of all papers not in hand.

This policy was amplified by the following motions:

Voted: That 15 days prior to the date set as the dead line for papers, the staff shall bring to the attention of all members of this Committee delinquent papers, and the committeeman in charge of the particular department shall take action necessary to insure receipt of the paper before the dead-line date or report on the dead-line date his failure to get the paper.

Voted: That all substitute papers must adhere to the dead-line date.

Program-Making Conference

The Committee decided to call a conference on June 30 of representatives of all professional divisions of the Society interested in participating in the programs of 1939 national meetings. In issuing the call for the meeting, it was stated that those divisions which intend to hold independent national divisional meetings during 1939 must be prepared to state their plans, including the proposed time and place of such meetings.

In accordance with the action of the Executive Committee of Council in providing for an Annual Meeting Conference of Professional Divisions, the Committee asked Elmo Caruthers, junior advisory member, to meet with J. N. Landis or another member of the Committee on Local Sections, who has had experience with the Conference of Local Sections Delegates, to develop an outline of a proposed agenda for the Professional Divisions' Representatives session at the 1938 Annual Meeting. Mr. Caruthers will present a report at the next meeting.

L. K. Sillcox New Chairman

In view of the departure of Crosby Field to Europe for a period of several months, his term as chairman of the Committee was concluded at his request with the May 18 meeting. L. K. Sillcox was then appointed to the chairmanship with Mr. Field continuing as a member of the committee.

Harvey N. Davis Welcomed Home at Stevens Dinner

"PREXY," as Harvey N. Davis is affectionately called by his students at Stevens Tech, came back from his trip through 22 states visiting the local sections of the A.S.M.E. in his official capacity as President of the Society and was welcomed home to Stevens at a dinner on May 18. Robert C. Post, member, A.S.M.E., who was chairman of the meeting, introduced Dr. D. S. Jacobus, past-president of the A.S.M.E.

Dr. Jacobus in his address of welcome said, "Dr. Davis has come back to Stevens after visiting the local sections of the A.S.M.E. as its President and it is indeed a pleasure to welcome him home. Meeting the members of the local sections is one of the most useful things that the president of the Society can do, because proper leadership of an engineering society requires much more than direction of its technical activities. Only by direct contact with members, especially those at a distance from Society headquarters, can one appreciate how much depends on the personal side of the problem, and no one is better fitted to enlist cooperation of all classes of members than Dr. Davis."

After mentioning the other Stevens men who had served as presidents of the Society, namely,

Robert H. Thurston, F. W. Taylor of '83, Alex C. Humphreys of '81, himself of '84, and Paul Doty of '88, Dr. Jacobus quoted from Dr. Thurston's presidential addresses to show how Dr. Davis is molding the courses at Stevens along the broad principles of engineering laid down by him in 1882.

Dr. Davis thanked all for their enthusiastic welcome and continued with interesting and entertaining comments on his recent trip in the course of which he made 54 addresses in 22 different states. In his closing remarks he mentioned the fact that Stevens had just received a gift from the Hayden Foundation of $25,000 for scholarships, it being the fourth $25,000 to be received this year, three of them within the last three months. He said that the money would be expended in bringing to Stevens young men from metropolitan New York and Boston.

Actions of A.S.M.E. Executive Committee

At the Meeting Held on May 16

THE MAY meeting of the Executive Committee of The American Society of Mechanical Engineers was held at the Society headquarters in New York, May 16, 1938. Present at the meeting were Harvey N. Davis, President, who presided, Harte Cooke, James W. Parker, Kenneth H. Condit, of the Committee; K. M. Irwin (Finance), J. N. Landis (Local Sections), advisory members; and C. E. Davies, secretary. A telegram of regret was received from James M. Todd, vice-chairman.

The following actions of general interest were taken.

United Engineering Trustees

Henry A. Lardner was reappointed representative to the United Engineering Trustees to serve a four-year term, ending in October, 1942.

Board of Honors and Awards

Upon the recommendation of the Board of Honors and Awards it was voted to award the Spirit of St. Louis Medal for 1938 to Major James H. Doolittle, Director of Aviation, Shell Petroleum Company, St. Louis, Mo., "for his contributions to the science of aviation and for his achievements in flying which have aided and extended his scientific accomplishments."

In response to an invitation from The Franklin Institute R. A. Wentworth was appointed the representative of the Society on the Advisory Committee of the Vermilye Medal which has recently been established by The Franklin Institute, Philadelphia, Pa., "in recognition of outstanding contribution within the field of Industrial Management."

Manual of Practice

The rates recommended for engineering work on housing projects under the program of the United States Housing Authority, as recommended by the Committee on Manual of Practice were approved.

Council Members' Informal Conference

President Davis reported a fruitful conference of the Council members who were present at the Los Angeles Meeting, on March 25, Harvey N. Davis, Frank H. Prouty, Frank O. Hoagland, Warren C. McBryde, E. W. Burbank, and W. Lyle Dudley. The discussion touched upon operating problems of Sections, National Meetings on the Pacific Coast, Society policy, Honorary Membership policy, program-making in the Local Sections, and related topics.

James Watt International Medal to Henry Ford

The Secretary reported that upon nomination by the A.S.M.E., Henry Ford had been selected by The Institution of Mechanical Engineers as the second recipient of the James Watt International Medal. The Medal, established by The Institution of Mechanical Engineers to commemorate the bicentenary of the birth of James Watt on January 19, 1736, is awarded every two years to an engineer of any nationality who is deemed worthy of the highest award the Institution can bestow and that a mechanical engineer can receive.

Appreciation

The Secretary read a letter of acknowledgment and appreciation from R. J. Durley, of the Society's letter to him of April 28, expressing good wishes upon his retirement as Secretary of the Engineering Institute of Canada.

A letter was also read from Lieut-Col. J. K. Clement of the New York Ordnance District, expressing appreciation for the cooperation of the Society in making available a room for the monthly meetings of the New York Ordnance District.

Rock Island Arsenal

Kenneth H. Condit was designated honorary vice-president to represent the Society at the celebration of the seventy-fifth anniversary of the Founding of Rock Island Arsenal, and at the meeting of the Army Ordnance Association at Rock Island, held May 25 coincident with the Celebration.

Program for 1938

Mr. Landis presented a tabulation showing the relationship between the Sections of the Society and local engineering societies. In the discussion of the operating problems, the conclusion was reached that local circumstances and views about organization differ so widely that it was difficult to draw conclusions on a national basis.

Attention was called to the fact that eight Sections comprise more than 55 per cent of the membership of the Society. Difficulties of program-making in the smaller Sections and in those Sections which are spread over a wide area were discussed and the assistance now being provided in the form of lists of speakers, films, etc. Recently a distinguished research engineer addressed several Sections, the expenses being borne cooperatively by the Sections addressed.

A bulletin of suggestions for those engaged in program-making was considered as was the importance of having the Sections develop their programs at an early date.

Appointments

Appointments were reported for record as follows: Local Sections Committee, W. F. Carhart, Junior Advisor. Professional Divisions, Elmo Caruthers, Junior Advisor. Admissions, Advisory Committee, R. E. Flanders and Roy V. Wright. Sectional Standardization Committee on Wire and Sheet-Metal Gaging Systems, Frederick G. Wilson. Safety Committee, Sectional Committees on Safety Code for Ventilation, Theodore F. Hatch; Ladders, Harry H. Judson; and Abrasive Wheels, John B. Chalmers. Daniel Guggenheim Medal Fund, E. A. Sperry, Jr. (3-year term). Thomas Alva Edison Foundation, Walter Kidde. Washington Award presentation to Dr. Frank B. Jewett, May 5, W. L. Abbott. The Franklin Institute ceremonies, May 19–21, H. N. Davis and C. N. Lauer.

71 Local Sections Finish Successul Year After Conducting 630 Meetings and Trips

Important Event of Local Sections in 22 States Was the Visit of President Harvey N. Davis

GREATER interest in the meetings of Local Sections of the A.S.M.E. was attested by the attendance at 630 meetings and trips held during 1937–1938. Reports received from every state in the Union and from Canada recount the many and varied programs arranged by the officers of each of the 71 Local Sections on which members and engineers from near and far presented papers describing the latest developments in the field of engineering.

The most important event during the year, according to the many letters and reports from members and officers of local sections, was the visit of President Harvey N. Davis, whose trip starting on Jan. 11 and ending in the middle of May, carried him through 22 states from coast to coast. Doctor Davis, who has been very busy, since returning, trying to catch up with his duties at Stevens Tech of which he is president, wishes us to pass along to the thousands of members and students who greeted him on his visits his sincere thanks and appreciation for the wonderful reception which was accorded to him.

The trip was most fruitful in increasing mutual understanding of Society problems and in laying a better foundation of friendship among

members and officers which will be of inestimable value in approaching future tasks.

Apprenticeship-Training Talks at Anthracite-Lehigh Valley

An important industrial and social problem of today, apprenticeship training, was the topic discussed at the meeting of May 27 of the Anthracite-Lehigh Valley Section in Allentown, Pa. C. R. Dooley, industrial-relations manager, Socony-Vacuum Oil Co., and W. F. Patterson, executive secretary, Federal Committee on Apprenticeship Training, both, leaders in the field, presented talks on the subject. The papers, which have been given previously at other meetings of the Society, will be found in the January and May, 1938, issues of MECHANICAL ENGINEERING.

Considerable discussion followed the remarks of the two speakers which brought out some interesting points, namely, the difference between a machine tender and a skilled worker, a method of insuring proper selection of boys for apprenticeship courses, and the standards of admission to such courses. Members A. C. Harper, Walter Trumbaur, J. R. Fairhurst, and several others took part in the discussion.

Detroit Section Holds Annual Meeting

On Wednesday, May 4, the Detroit Section of the A.S.M.E. was host to members of the student branches at Michigan State College, University of Michigan, and the University of Detroit. In the afternoon the student members were conducted on a tour of inspection through the plant of the U. S. Rubber Products Co. In the evening more than 250 members and students gathered at a banquet in honor of Harvey N. Davis, President of the Society, who spoke on "The Engineer and the Future." J. W. Parker, vice-president of the Society, who served the gathering as toastmaster, helped to create a feeling of fellowship and friendship with his remarks. C. J. Freund, dean of engineering at the University of Detroit and chairman of the Detroit Section, was chairman of the meeting. Short talks appreciative of the reception given to the student members were made by Dean H. B. Dirks, Michigan State, Prof. J. E. Emswiler, University of Michigan, and Dean Freund, University of Detroit. Prof. Hugh Keeler, University of Michigan, was in charge of arrangements for the meeting.

Knoxville Holds Meeting in Kingsport, Tenn.

The Knoxville Section held its last scheduled meeting of the year at Kingsport, Tenn., on May 17. Everyone who was present voted it as one of the best meetings held so far. At the afternoon session, A. J. Moses, general manager, Hedges-Walsh-Weidner Division, Combustion Engineering Co., spoke on "The Fabrication and Welding of Stainless Alloys." In the evening, following a visit to Kingsport industrial plants and a dinner at the Kingsport Inn, the meeting, presided over by F. L. Wilkinson, Jr., chairman, Knoxville Section, featured a talk on "Problems Relating to Industrial Mobilization," by Capt. D. N. Hauseman, chief, Procurement Planning Section, Ordnance Department, U. S. Army, and a paper on "Recent Developments in Air Conditioning," by Elmer Torok, member, A.S.M.E., and mechanical engineer, North American Rayon Corporation.

Raleigh Section Meets at Duke University

The last regular meeting of the Raleigh Section was held on May 16 at Duke University. The program, which was acclaimed one of the best presented so far, featured papers of an exceptionally high order by student members. Fred Ullman demonstrated and spoke on "An Experimental Radial Engine." W. G. Jerome illustrated and spoke on "Noise in Industry." "Photoelasticity and Its Application to Industry" was discussed by M. C. Brennon. As a balance to these highly technical papers, Prof. C. F. Chute, University of North Carolina, entertained with sleight-of-hand and magic tricks, his performance being of a professional nature. Members admitted that this was the only feature of any program throughout the entire year from which nothing was learned.

Other Local Sections News

Akron-Canton

Meeting at Young's Hotel on May 26, the members of the Akron-Canton Section heard all about "Small Arms Production" from Major Walter H. Soderholm, U. S. Army.

Atlanta

On May 16, a meeting was held at the Atlanta Athletic Club by the Atlanta Section to hear George Wheeler, The Polaroid Co., describe the use and application of polarized glass.

Boston

M.I.T. was the scene of the May 19 meeting of the Boston Section. John A. Chambers, district sales manager, Johns-Manville Corp., discussed "Noise, a Modern Problem."

Chicago

The Management Division of the Chicago Section, meeting on May 31, featured C. S. Carney, consulting engineer, Stevenson, Jordan & Harrison, who talked on "Pricing, Costs, and Profits." The paper took up the basis for pricing, relationship of costs, and determination of profit.

Cincinnati

Golf, swimming, and horseback riding were indulged in by members of the Cincinnati Section at their annual outing, held this year at the Kenwood Country Club on May 26. Following a dinner in the evening, the new officers were introduced, after which a fine program of entertainment was provided for the edification of those present.

Colorado

A combined meeting and inspection trip was held by the Colorado Section on May 20 at the Public Service Co., of Colorado, Valmont plant. A. H. Heitzler, superintendent, electrical department, and R. F. Throne, member, A.S.M.E., in a paper entitled, "Valmont's Answer to the Capacity Problem," described the details of the design and operating characteristics of the new Babcock & Wilcox boiler, evaporating 225,000 lb of steam per hr, and the new 25,000 kw General Electric turbine. After the talks, members adjourned to the plant to inspect the new equipment.

Dayton

Capt. D. N. Hauseman, U. S. Army, who has spoken before other local sections of the A.S.M.E. in different parts of the country, was the guest speaker of the Dayton Section on May 13.

Hartford

Diesel engines were discussed by Vander Eb at a meeting of the Hartford Section on May 31, the talk dealing particularly with insurance inspection.

Los Angeles

A dinner meeting was held on May 18 by the Los Angeles Section at which, W. W. Kerlin, metallurgist, Mehanite Metal Corporation, spoke on "Modern Irons for Machine Construction." As their contribution to the program, the Junior members presented the sound motion picture "Bridging a Century." This picture, produced and shown through the courtesy of John A. Roeblings Sons Co., shows the building of the Golden Gate Bridge from the beginning of construction to its final completion.

Metropolitan

A special meeting under the auspices of the Power Division of the Metropolitan Section was held on May 25 to enable members to listen to a paper on the "Development and Adaptation of the Hydraulic Coupling for Variable-Speed Drive on Auxiliary Power Equipment," by Harold Sinclair, managing director, Hydraulic Coupling and Engineering Company, Ltd., Islewort, England. The talk was based on a paper delivered by Mr. Sinclair before The Institution of Mechanical Engineers in London on April 22, 1938. An abstract of this and another paper presented in 1935 before the I.M.E. together with several illustrations will appear in the Briefing the Record section of the August issue of MECHANICAL ENGINEERING.

Mid-Continent

"Physics in the Petroleum Industry" was discussed by Dr. Morris Muskat, chief of the

physics division, Gulf Development Corporation, at a meeting attended by more than 100 members and guests of the Mid-Continent Section on May 9 in Tulsa, Okla.

Milwaukee

Ira Milton Jones, patent lawyer of Milwaukee, discussed the patent laws of the United States and their relation to the industrial success of the country at a meeting of the Milwaukee Section on May 26. He discussed in detail the McFarlane bill which will provide for the compulsory licensing of patents. However, the bill has been dropped according to a news item from the American Engineering Council published in the June issue of MECHANICAL ENGINEERING.

Minnesota

Following a visit to the new foundry laboratory of the University of Minnesota, May 18, the members of the Minnesota Section arranged a meeting at the school at which A. M. Severson, R. G. Brederson, R. Henning, student members, A.S.M.E. presented papers for prizes awarded by the Section.

Nebraska

A joint meeting was held by the Nebraska Section with the Nebraska Section of the A.I.E.E. at the Rome Hotel in Omaha, May 27. The speaker was E. R. Morris, consulting engineer and president of the Omaha Engineers' Club, who talked on "Artificial Weather—How Produced and Distributed."

North Texas

A 45-minute sound film entitled, "Flow" and a talk on valves and valve design by W. F. Lahl, Crane & Co., was presented at a meeting of the North Texas Section in Dallas, Texas, May 9.

Ontario

Following an inspection trip through the local plant of the Babcock-Wilcox & Goldie McCullock Co. on May 20, members of the Ontario Section learned about the modern developments in boiler practice from Alfred Iddles, Fellow, A.S.M.E., and assistant to the vice-president in charge of engineering, Babcock & Wilcox Co.

Oregon

Presentation of technical papers in competition for two prizes awarded by the Oregon Section was made by student members of the Oregon State College Student Branch at a meeting of the Section held in Corvallis, Ore., May 14.

Peoria

Together with members of the Chicago Section, A.S.M.E., the members of the Peoria Section attended the celebration of the 75th anniversary of the founding of the Rock Island Arsenal on May 25. A report of the affair is given elsewhere in this issue.

San Francisco

An interesting paper, entitled, "The Engineer's Franchise in America," was given before the San Francisco Section on May 26 by F. T. Letchfield, member, A.S.M.E., consulting engineer and assistant vice-president, Wells Fargo Bank & Union Trust Co.

Utah

The meeting on May 26 of the Utah Section was a joint session with the University of Utah Student Branch. The program was arranged and papers presented by the student members. Those who spoke were Howard Hassell, Oscar C. Wilde, K. Frederick Miles, and Henry Mattson.

Syracuse

At the final meeting of the fiscal year held on April 21, Willis H. Carrier, A.S.M.E. Medalist and member of the Society, outlined the history of air conditioning and explained the technical and commercial aspects of the subject. An audience of 75 members was present.

Washington, D. C.

More than 100 members and guests were present at the May 18 meeting of the Washington Section to listen to a lecture on "Loxology," by Maxwell C. Maxwell, who presented this very interesting and educational talk before hundreds of other A.S.M.E. members and student members in his visits during the last few years to local sections and student branches.

Waterbury

Ladies' night on May 18 attracted more than 70 members and their lady guests. In keeping with the occasion, the guest speaker, Dr. L. V. Burton, spoke on "Industrial Kitchendom." He showed how the engineer had invaded the domain of woman and made possible the mass processing and cooking of foods. Continuing, he made predictions of new kinds of food in the future. Then, Dean S. W. Dudley of Yale University and Manager, A.S.M.E., spoke on A.S.M.E. activities, membership, and finance.

Worcester

Worcester Polytechnic Institute was the meeting place of the Worcester Section on May 10 when J. E. Doyle, supervisor of personnel, General Electric Co., spoke on the selection and training of new employees.

Youngstown

About 100 members and 50 visitors turned out on April 26 to hear John L. Young, United Engineering and Foundry Co., describe a modern four-high hot- and cold-strip mill. He also showed sound films on the installation of rolling-mill equipment.

Fifth International Congress for Applied Mechanics at Cambridge, Mass., Sept. 12–16, 1938

Abstracts of Papers to Be Published in the September, 1938, issue of the "Journal of Applied Mechanics"

THE FIFTH International Congress for Applied Mechanics, a meeting of individuals interested in applied mechanics, will take place in Cambridge, Mass., Sept. 12–16, 1938, with Harvard University and the Massachusetts Institute of Technology acting as hosts. General lectures and communications will be read during the first four days of the Congress in the lecture halls of M.I.T. On the fifth day, the sessions will be held at Harvard.

Applied Mechanics Division Cooperates

Since the Applied Mechanics Division of the A.S.M.E. is a cooperating sponsor, English abstracts of all papers, about 100, will be published in the September, 1938, issue of the *Journal of Applied Mechanics*. Complete papers will appear in the Proceedings of the Congress to be published by the Technology Press with J. P. Den Hartog, member, A.S.M.E., and Professor at Harvard University, and Heinrich Peters, professor, M.I.T., as editors. Participating members may secure the Proceedings at $4 per copy in advance, or $6 per copy after the Congress.

The program contemplates the presentation of six general lectures by invitation, a turbulence symposium, and about 100 papers from participating members written in English, French, or German. It is expected that the field of applied mechanics will be covered under the following general heads: (1) Structures, elasticity, plasticity, fatigue, strength theory, and crystal structure; (2) hydro and aerodynamics, gas dynamics, hydraulics, meteorology, water waves, and heat transfer; (3) dynamics of solids, vibration and sound, friction and lubrication, and wear and seizure.

For Further Information

Any A.S.M.E. member desiring to attend the Congress should write for further information to one of the joint secretaries, J. C. Hunsaker or Th. von Kármán, Fifth International Congress for Applied Mechanics, M.I.T., Cambridge, Mass.

Rock Island Arsenal Has 75th Anniversary

A CELEBRATION to commemorate the seventy-fifth anniversary of the founding of the Rock Island Arsenal in Illinois was held there on May 25 in conjunction with the Nineteenth Annual Meeting of the Army Ordnance Association. Following an inspection of the various shops and areas of the Arsenal, a dinner was held in the Fort Armstrong Hotel in the City of Rock Island. Kenneth H. Condit, Manager, A.S.M.E., represented the Society at the celebration, being designated an honorary vice-president for the occasion.

AT THE BANQUET OF THE A.S.M.E. OIL AND GAS POWER DIVISION DURING ITS MEETING IN DALLAS, TEX.

A.S.M.E. Oil and Gas Power Division Holds Successful Meeting at Dallas, June 6–9

North Texas Section of the Society Host to Many Engineers From the Petroleum-Producing Area

THE eleventh national Oil and Gas Power Meeting of the A.S.M.E. was held in Dallas, Texas, from June 6 to 9, inclusive, with the Baker Hotel as convention headquarters. The North Texas Section of the Society coöperated with the Oil and Gas Power Division in planning the convention. Air-conditioned quarters were provided for all functions of the meeting, including the exhibit space which was adjacent to the convention hall.

Inasmuch as the convention was held in the center of the world's largest petroleum-producing area, many of those in attendance were engineers connected with this industry. Most of the papers presented were of particular interest in the operation and maintenance of oil and gas engines. This interest was in evidence on Tuesday, June 7, when the largest number, about 200, were in attendance.

Papers of Special Interest

The papers that created the most interest, as measured by the discussion and comments of the audience, were:

"Lightweight Materials for Internal-Combustion Engines"
"Essential Factors Contributing to the Success of a Maintenance Program"
"Operating Experiences of a 2-Cycle Diesel Engine, Using Gas Fuel on the Diesel Cycle"
"Municipal Lighting and Power Systems Using Diesel Prime Movers"
"Theory, Application, and Benefits of Engine Vibration Isolation"
"Wear of Piston Rings and Cylinder Liners"

Other papers presented were of such a diversified nature that the program covered all of the important phases of oil- and gas-engine developments, applications, operations, maintenance, fuels, and trends. These were:

"Recent Developments, Applications, and Trends of High-Speed Diesel Engines"
"The Trends and Load Characteristics of Power Application for Pumping Oil Wells"
"Recent Developments of Cooling Towers and Their Application to Gas and Diesel Engines"
"Modern Governing Equipment"
"The Diesel Engine in High-Speed Railroad Service"
"Latest Developments in Diesel Fuel Testing"
"The New DeJuhasz Pressure Indicator."

Excellent Facilities for Exhibitors

A feature of the convention was the excellent facilities provided for the exhibitors. Exhibits were placed by Aluminum Company of America, American Air Filter Company, American Hammered Piston Ring Company, Diesel Equipment Corporation, Diesel Power Magazine, Diesel Progress Magazine, Double Seal Ring Company, Hercules Motors Corporation, Illinois Testing Laboratories, Motor Improvements, Incorporated, Scintilla Magneto Company, SKF Industries, Incorporated, United American Bosch Corporation, and Zenith Carburetor Company. The interest in the exhibits was greater at this meeting than at any of the previous OGP conventions. This was probably due to the excellent facilities provided.

Unfortunately there were not very many visiting ladies present to enjoy the delightful program of entertainment provided by the Dallas Ladies Committee, of which Mrs. E. F. Schmidt was chairman.

A popular feature of the program was the inspection trip to the Guiberson Diesel Engine Aircraft Plant and to the Gas Engine Power Plant in the Lone Star Gas Building. The latter plant was of particular interest because of the several types of vibration isolation methods used for mounting the three natural gas engines.

The feature of the annual banquet was an address by Joe J. Taylor, editor in chief of the *Dallas News*, the subject of which was "High, Wide, and Handsome." In an interesting and entertaining manner Mr. Taylor painted a word picture of what a newspaper editor thinks of the engineer and his product.

During the banquet sound films "Diesels Working on the Railroad," by courtesy of the Burlington Railroad Company, were shown. These films showed the history and development of motive power for rail transportation and with emphasis on the modern trends and applications of the Diesel engine to high-speed railroad service.

Those actively in charge of the meeting were E. J. Kates, chairman, and M. J. Reed, secretary of the Oil and Gas Power Division, H. E. Degler, chairman of the Arrangements Committee, H. R. Pearson, chairman, and H. M. Robinson, secretary of the North Texas A.S.M.E. Section. Cooperating with this group were E. W. Burbank, member of Council, and Ernest Hartford, assistant secretary of the Society.

HOWARD E. DEGLER.[1]

Daniel Guggenheim Gold Medal Awarded to A. H. R. Fedden

THE 1938 Daniel Guggenheim Gold Medal was awarded on May 18 at a meeting of The Daniel Guggenheim Medal Board of Award to Alfred H. R. Fedden, chief engineer of the Bristol Aeroplane Co., Ltd., Bristol, Gloucestershire, England, "for contributions to the development of aircraft-engine design and for the specific design of the sleeve-valve aircraft engine."

Official representatives of the A.S.M.E. on the Daniel Guggenheim Medal Fund, Inc., board are William B. Mayo, Thomas A. Morgan, and Elmer A. Sperry, Jr. Also, there are the following A.S.M.E. members representing other societies: John H. R. Arms, Sherman M. Fairchild, Lester D. Gardner, Theodore P. Wright, and George J. Mead. Others on the board are Charles H. Chatfield, George W. Lewis, and J. H. Kindelberger.

Arrangements for the presentation of the medal were referred to a committee composed of T. P. Wright, Elmer A. Sperry, Jr., and Lester D. Gardner.

[1] Professor of Mechanical Engineering, The University of Texas. Mem. A.S.M.E.

Nathanael Greene Herreshoff

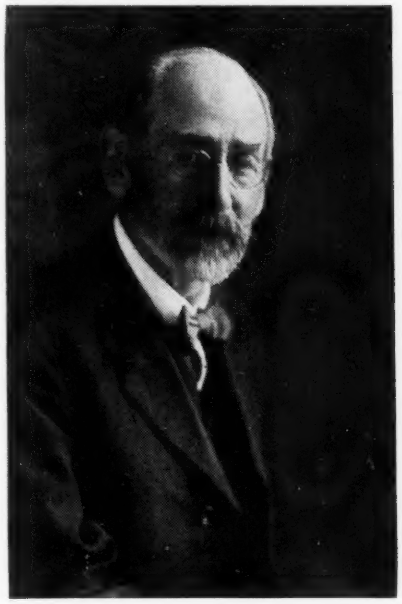
Honorary Member, A.S.M.E., Dies at Age of 91

NATHANAEL GREENE HERRESHOFF, who was elected to honorary membership in the A.S.M.E. in 1921, died at his home in Bristol, R. I., on June 2, 1938, in his ninety-first year. At the age of thirty he joined the Herreshoff Manufacturing Company, founded in 1863 by his brother, John B. Herreshoff, famous blind designer and builder of pleasure and commercial vessels. Nathanael Herreshoff became superintendent of the company in 1881 and its president in 1915. He retired from business in 1924.

The firm was most widely known as builders of the yachts which defended the United States in the international races. Between 1893 and 1920 Mr. Herreshoff designed five of these: The *Vigilant*, 1893, *Defender*, 1895, *Columbia*, 1899 and 1901, *Reliance*, 1903, and *Resolute*, 1920. The Herreshoff yachts also won many other cup races.

Thousands of boats, of all types, were built by the Herreshoff brothers. The *Gloriana*, a sloop designed by Nathanael Herreshoff in 1891, embodied the spoon bow and other features which are used in fast yachts of today. The bulb fin boat, with its light, shallow hull and deep ballasted fin, was another Herreshoff invention, as were other improvements in hull design, as well as in methods of rigging. The *Lightning*, designed and built by the Herreshoff brothers, was the first torpedo boat owned by the United States.

Mr. Herreshoff was born at Bristol on March 18, 1848. Before joining his brother in 1878 he had spent three years at the Massachusetts Institute of Technology, receiving an M.E. degree in 1869, and nine with the Corliss Engine Company, of Providence. He had secured several patents on steam-engine regulators; and participated in the design and personally installed the walking-beam Corliss engine shown at the Centennial Exposition in 1876. He was a pioneer in the design of compound steam engines. One of his first achievements after joining the Herreshoff Manufacturing Company was the perfection of the coil boiler for use on steam yachts.



NATHANAEL GREENE HERRESHOFF

Mr. Herreshoff was a member of the Institution of Naval Architects, The Society of Naval Architects and Marine Engineers, and The Franklin Institute, as well as of a number of yacht clubs. In 1896 he received an Sc.M. degree from Brown University, which was founded by his great-grandfather, John Brown.

Junior Group Activities

Metro Group Reports on 1937–1938 Activities

IN A YEAR marked by several innovations in policy, the Metropolitan Junior Group continued to improve and expand its activities, basing much of its planning on a comprehensive questionnaire sent to 1200 Juniors, in July, 1937.

All regular meetings, with one exception, were scheduled in answer to requests, and were featured by active participation. Two specialized groups, the Air-Conditioning Seminar and the National Defense Seminar, presented a series of well-planned and well-attended meetings. Next year emphasis will be on Junior papers, and an effort will be made to reduce overlap between Senior and Junior programs.

An active publicity committee has worked with college papers, and has presented brief talks at three local colleges. Future publicity activity will include technical magazines and suburban papers. To increase active membership, letters and questionnaires were sent to recently transferred student members, and two meetings were held jointly with student branches.

The Employment Advisory Committee has functioned as usual, advising men in the technique of obtaining jobs, discussing interviews, letter writing, and advertisements, and occasionally giving leads. A plan for career guidance by senior councilors is now being worked out and will soon be in operation, and the Group is cooperating with the Seniors on a somewhat similar plan for student councilors.

The annual report, outlined above, was presented by Walter W. Lawrence, secretary-treasurer, at the last meeting of the season, held May 24. Two Junior papers were also presented: "The Finical Processing of Hot-Drink Paper Cups," by John R. Cave, and "Measured-Day Work," by Frederick C. Winter.

Baltimore Juniors Invite Seniors to Annual Dinner

SENIOR members of the Baltimore Section were invited to attend the annual dinner and lecture of the Junior Group, held May 24 at the Johns Hopkins Club. The guest speaker at the dinner was Prof. A. G. Christie of Johns Hopkins University, and the three-part lecture was on "Cameras and Photography."

Speaking on "Camera Fundamentals," Lawrence Hartman presented a brief history of photography followed by a discussion of the optics and mechanics of the camera. The second part of the lecture, "The Chemistry of Photography," was covered by Wentworth Boynton. After a synopsis of the fundamental processes involved, the talk turned to practical matters such as kind of film, method of development, and preparation of the final print. Color photography was also discussed, with a description of the additive and subtractive process. The lecture was completed by Will Hazlett who spoke of "Modern Photographic Equipment and Applications." Merits and demerits of many types of cameras were presented and accessories such as range finders, exposure meters, and enlargers were considered. The talks were illustrated with diagrams and a complete display of the equipment discussed.

Cleveland Juniors Visit Warner & Swasey Plant

AN INSPECTION trip through the plant of the Warner & Swasey Co. was the high spot of the May program of the Cleveland Junior Group. Founded by Worcester Reed Warner and Ambrose Swasey, the company manufactures a complete line of precision turret lathes, and astronomical telescopes.

The 40 engineers present were impressed by the modern machinery and methods used in the plant. Interesting and accurate information as to routing, materials, tool, and stock handling, and other production procedures was furnished by the guides, five members of the production control department, headed by Chester Cowdrey. The meeting was arranged by Allan Phelps, of the Junior Group.

South Texas Juniors Inspect Tool Plant

MORE than 45 members of the South Texas Junior group inspected the plant of the Hughes Tool Company in Houston, May 6. The trip included the machine shops, heat-treating departments, tool and die room, foundry, and forge shop.

Attention of the Juniors was held by an in-

genious machine for reproducing in a metal die the contours of a wooden pattern. In this machine, the Keller, a pointer follows the pattern and its motion is transmitted electrically to the cutting tool.

Before adjourning, the group assembled in the taproom of the Gulf Brewing Co., where refreshments were served and the meeting ended in a spirit of joviality and comradeship.

St. Louis Group Hears Talk on "The Young Engineer"

THE MANAGEMENT Division of the St. Louis Junior Group held a unique meeting on May 20, when invitations were issued to discuss "What Management Requires of the Young Engineer" with Walter Siegerist, president, The Medart Co. Mr. Siegerist spoke from long industrial experience with companies such as the Heine Boiler Co., Combustion Engineering Co., and Midwest Piping and Supply Co. The meeting was in charge of E. B. Fremon and N. O. Anderson.

Waterbury Juniors Close Successful First Season

THE FIRST full year of the Waterbury Junior Group was brought to a conclusion on June 4, by an inspection trip through the plant of the Waterbury Farrel Foundry and Machine Co.

Since its inception in December, 1936, under the leadership of A. L. Davis and C. W. Rush, the Group has grown rapidly. Meetings are held in the informal atmosphere of the University Club rooms at the Hotel Elton, through the courtesy of Herman Koester, president of the University Club and senior councilor of the Group. It has been the policy of the Group to invite to its meetings all men of Junior Group age, and eligible for membership in the Society.

During the past year nine meetings were held, five Junior papers were presented, and five guest speakers were heard. The group was headed by Russell B. Bass, chairman; Carl N. Pepperman, vice-chairman; and Gregory N. Tyack, secretary-treasurer. The officers for the coming year are Gregory N. Tyack, chairman; and Henry Ashley, secretary-treasurer.

Kansas City Juniors Feature Preparedness Papers

TAKING the place of John R. Stone, who was sick, J. Marsland talked at a regular meeting of the Junior Group on May 10 on the subject, "Is Our Army Preparing for the Next or the Last War?" He reviewed the methods and results of mobilization for the World War as well as plans for future emergencies, showing how the U. S. Army is better prepared than ever before.

Then Skyllingstad described "The Factory Assembly Line." Verne Hall concluded the evening's program with a paper on "Ford's Decentralization Plan."

Seventh International Management Congress Washington, D. C., September 19–23, 1938

Members and Management Division of A.S.M.E. Active in Formulating Congress Program

MANAGEMENT will have a great opportunity to reappraise its responsibilities and opportunities and to show that its main purpose is the promotion of the welfare of the people in the forthcoming Seventh International Management Congress, in Washington, D. C., Sept. 19–23. This is the first Congress to be held in the United States, where the "management movement" has its origin. World Congresses have previously been held in Prague, Brussels, Rome, Paris, Amsterdam, and London. It is expected that from 2500 to 3000 delegates will be in attendance at the Washington meeting, with nearly 300 visitors coming from more than 40 countries.

A.S.M.E. Represented

The Congress, which is a triennial affair, will be held under the auspices of the International Committee of Scientific Management, of which the Right Honorable Viscount Leverhulme of Great Britain is president, and Harry Arthur Hopf, member, A.S.M.E., is deputy president. The chairman of the Coordinating Committee directing the Congress is William L. Batt, past president, A.S.M.E. Representing the United States in the meeting is the National Management Council of the United States of America. Included in the member organizations making up the Council are The American Society of Mechanical Engineers, American Management Association, and the Society for the Advancement of Management.

Other members of the Society heading committees of the Congress as chairmen or vice-chairmen are William H. Gesell, Frederick M. Feiker, Fairfield E. Raymond, Harold V. Coes, Ernest Hartford, Walter D. Fuller, Ralph E. Flanders, William F. Hosford, and Lillian M. Gilbreth. A.S.M.E. members on the American Congress Council consist of Howard Coonley, William C. Dickerman, Charles F. Kettering, Frank W. Lovejoy, James H. McGraw, James D. Mooney, and F. A. Schaff.

General Sessions

Speakers from the United States and foreign countries will discuss the economic and social forces affecting business enterprise in present-day society. Addresses will be given in pairs to introduce the American and the foreign points of view on these aspects of management.

Technical Sessions

Technical committees on administration Walter D. Fuller, member, A.S.M.E., chairman, production Ralph E. Flanders, past-president, A.S.M.E., chairman, distribution, personnel, agriculture, and home management, have obtained papers from more than 200 experts from 40 nations. Discussion of the recent developments in management techniques will be based on topics covered under the following main headings:

Administration: Administrative and financial controls, organization, executive personnel, public administration, and office management. *Production:* Manufacturing management (general applications, coordination of functions, decentralization of industry, research and development, purchasing and insurance), plant layout, processing, equipment, production controls, material controls, quality controls, work simplification, and cost methods and accounting for control. *Distribution:* Market analysis, sales planning, market outlets, trade channels, costing, pricing, advertising, sales promotion, and administration of sales. *Personnel:* Industrial relations, personnel function, collective cooperation, wage administration, incentives, training, vocational guidance, applied psychology, accident prevention, safety, health, unemployment, and social security.

Tours

Foreign and American delegates will be given an opportunity to make tours of several sections of the country, visiting selected examples of American management practice.

Publications of Congress

Proceedings of the Congress, printed in seven volumes, will be made available to all delegates, and at a nonprofit price to all others. Further information may be obtained through A.S.M.E. Headquarters or directly from Congress Headquarters, Room 1201, 347 Madison Avenue, New York City.

World Power Conference Sectional Meeting at Vienna in August

A SECTIONAL meeting of the World Power Conference will be held this year at Vienna, where delegates and members will assemble on Aug. 25 for an intensive week of discussion touching on all phases of power supply to consumers.

The papers and discussions will deal with the supply of energy for agriculture, small-scale industries, household purposes, public lighting, and electric railways, with emphasis placed on the point of view of the consumer. Participating members from all over the world will exchange ideas and detail experiences in all these fields, discussing the distribution and application of energy, rates and schedules, market analysis, methods of finance, government action in the matter of energy supply, and the influence of taxation on tariffs.

In addition to the serious business of the conference, the Committee has arranged a social program and a series of excursions of the greatest interest. A.S.M.E. members may secure detailed information from the Executive Committee of the United States National Com-

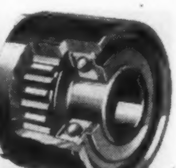
(*Continued on page 588*)

20,000,000

ACCURATE RATCHET MOVEMENTS IN A YEAR

AND NOT A BIT OF TROUBLE *With the* MORSE HIGH TORQUE CLUTCH

Morse

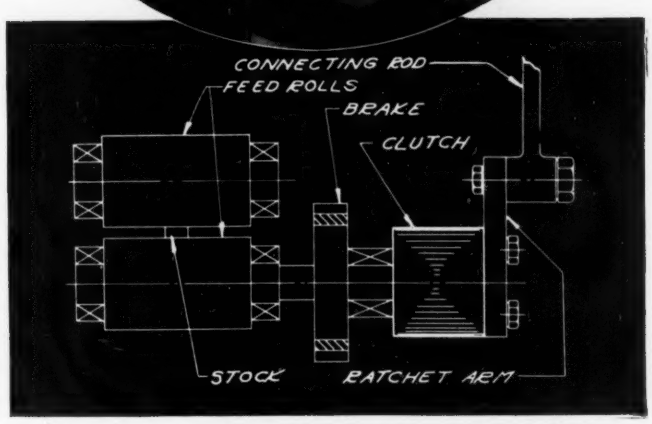


FREE WHEELING AND INDEXING CLUTCHES

120 times a minute, the Morse High Torque Clutch moves flat bar stock into the mouth of this press. It's a job calling for complete dependability and accuracy, and the Morse Clutch, replacing a ratchet feed, has done the job without a bit of trouble of any kind since installation a year ago.

Morse Clutches are sturdily built to do precision jobs with ease and dependability. Adaptable to a wide range of power applications, they will fit into free wheeling operations with complete success, as they free wheel without appreciable drag or drive smoothly and steadily when shaft speeds synchronize. And in ratcheting and indexing uses, Morse clutches are compact, simple, and efficient in replacing bulky, complicated mechanisms.

In hundreds of power transmission uses, Morse Clutches are setting new standards of efficiency and trouble-free operation. The Morse man in your territory will be glad to consult with you on ways in which you can utilize these power-saving, money-saving pieces of power transmission equipment.



Above is a press for punching hex nuts. The Morse High Torque Clutch indexes 1/8" flat bar stock up against a gauge by means of feed rolls, with 120 ratchet movements per minute. The Morse Clutch replaced a ratchet feed on this machine, with great improvement in efficiency.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

mittee, World Power Conference, Room 1409-S, 4 Irving Place, New York, N. Y.

A.S.M.E. Members Elected to Industrial Conference Board

NEW MEMBERS of the Executive Committee of the national Industrial Conference Board, elected at the twenty-second annual meeting in New York City, the latter part of May, include the following A.S.M.E. members: Ernst R. Behrend, president, Hammermill Paper Company; Philip E. Bliss, president, The Warner & Swasey Company; Wm. C. Dickerman, president, American Locomotive Company; and Auguste G. Pratt, president, Babcock & Wilcox Company.

A.S.M.E. Members at Engineering Congress in Glasgow

BESIDES the official representatives of the Society, George A. Orrok, honorary member, A.S.M.E., and George A. Stetson, member, A.S.M.E., several other members, according to latest advices, were planning to attend the International Engineering Congress in Glasgow June 21–24, as "unofficial representatives" of the Society. These were Philip L. Alger, engineering staff assistant, General Electric Co., H. J. Bowker, erecting engineer, Babcock & Wilcox Co., F. D. Herbert, president, Kearfott Engineering Co., C. W. Middleton, vice-president, Babcock & Wilcox Co., Arthur M. G. Moody, instructor in mechanical engineering, University of Delaware, and W. V. Sauter, president, American Engineering Co.

Julius Billeter Represents A.S.M.E. Utah State College

OFFICIAL representative of the Society at the Semi-Centennial Celebration of the Founding of the Utah State Agricultural College, Logan, Utah, June 5–7, was Julius Billeter, who was appointed an honorary vice-president for the occasion.

H. Birchard Taylor Elected President of Navy League

MEETING in New York City on May 12, the members of the Navy League of the United States elected H. Birchard Taylor, past vice-president of the A.S.M.E., as their new president. Mr. Taylor, a great-grandson of William Cramp, founder of the Cramp Shipbuilding Company, succeeded N. M. Hubbard, Jr., who has headed the League for the past two years.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

GRADUATE MECHANICAL ENGINEER, Villanova, 1934. Two years' design machine tools and automotive-production machinery. Two years' design production machinery to manufacture sporting goods. Plant layout. Practical inventive ability. Me-96.

JUNIOR MECHANICAL ENGINEER, 1937 graduate, age 23. One year tool design, jigs and fixtures, some cost accounting. Seeks production planning or design position preferably in New York or New England. Me-97.

MECHANICAL AND STRUCTURAL ENGINEER with 25 years' experience copper, textile, chemical-plant engineering, desires position as works, maintenance, research engineer, or chief draftsman. Speaks Spanish and German. Me-98.

PROFESSOR OF INDUSTRIAL ENGINEERING AND ADMINISTRATION. Wide teaching experience, exceptional training as plant superintendent and factory manager. In charge of research and experimental work. M.M.E. degree, Cornell. Me-99.

MECHANICAL ENGINEER, college graduate, some electrical training, experienced in heating and ventilating, air-conditioning, mechanical-draft and air-handling work. Willing to travel. Western New York preferred, but will go anywhere. Me-100.

ASSISTANT PROFESSOR OR INSTRUCTOR, mechanical or industrial. Graduate mechanical engineer with master's degree. Six years' experience in shop and costs; two years college teaching. Married. South or central preferred. Me-101.

MECHANICAL ENGINEERING GRADUATE, 28. Specialized in industrial organization and power-plant design; four years' experience in planning, coordination, supervision; also knowledge of billing, purchasing, expediting, construction methods. Me-102.

MECHANICAL ENGINEERING INSTRUCTOR, M.I.T. graduate, master's degree. Teaching thermodynamics and mechanical laboratory at leading technical institution in East. Major fields are thermodynamics, refrigeration, air conditioning, and power-plant engineering. Me-103.

MECHANICAL ENGINEERING GRADUATE, former secretary, estimator engineering sales-promotion work. Year of production engineering; 14 months as test engineer on internal-combustion engines and compressors. Desires opportunity to utilize business and engineering experience. Me-104.

MECHANICAL ENGINEER, B.S. in 1936. Two years' experience in design of production equipment. Desires position in connection with aeronautics, or teaching in university with opportunity of working for M.S. in aeronautics. Me-105.

MECHANICAL ENGINEER, 23, single, B.S., mechanical engineering, University of California, 1937. Tau Beta Pi. Good draftsman, computer, report writer. Industrious, adaptable. Available immediately. Location, immaterial. Me-106-384 D-4 San Francisco.

EXECUTIVE ENGINEER, graduate. Fifteen years' experience sales, management, construction, rates, valuation; utility and industrial power, Diesel, steam, hydro, distribution; also air conditioning. New York license. Will travel. Location preferred, East. Me-107.

CORNELL UNIVERSITY, 1929, M.E., telephone and gas utility planning, general knowledge business, drafting, stock control, selling gas-burning equipment to commercial establishments since Jan., 1937; personality, single, ready to travel. Me-108.

POSITIONS AVAILABLE

DESIGNER with at least 5 or 10 years' experience in design of Diesel engines. Apply by letter. Location, New York, N. Y. Y-2967.

GRADUATE ENGINEERS, 1 or 2, ages 26–38, to act as consultants for woodworking industries. Service covers all management problems, with emphasis on reduction of costs through wage-incentive plan. Experience in woodworking desirable. Must be free to travel. Salary, $75 a week plus traveling expenses. Apply by letter. Headquarters, Middle West. Y-2970C.

ASSISTANT PROFESSOR of mechanical engineering. College desires man whose specialty is power plants and thermodynamics. Apply by letter. Location, South. Y-2974.

DESIGNER, mechanical engineer, not over 45, preferably with wire and wire-drawing experience. Apply by letter. Location, New York, N. Y. Y-2932.

SALES ENGINEER, 26–35, to sell cutting oils, core oils, and greases to industrial plants. Must have sales experience, and be thoroughly acquainted with machine shops. Should own car. Traveling. Salary, expenses, and commission. Apply by letter. Headquarters, New York, N. Y. Y-2987.

INDUSTRIAL ENGINEER to take charge of industrial-engineering department. Must have training and experience in time-study work, setting of standards and installation of wage systems. Must also have experience in motion study along lines of Gilbreth system. Apply by letter. Location, South. Y-2990.

INSTRUCTOR to teach machine design, kinematics, and associated subjects such as applied mechanics. Must have graduate training in advanced machine design, and should have practical experience. Apply by letter. Location, South. Y-2995.

ASSISTANT PROFESSOR, graduate of mechanical- or aeronautical-engineering course, three to five years out. Will teach kinematics, mechanical-engineering laboratory, and one course each semester in aeronautics. Training or experience along aeronautical lines, preferably aerodynamics, airplane structures, and airplane dynamics essential. Salary, $2400 for nine months, beginning September 15, 1938. Apply by letter. Location, South. Y-2996.

INSTRUCTORS, 2, graduate mechanical or elec-

(*Continued on page 590*)

[1] All men listed hold some form of A.S.M.E. membership.

trical engineers to take charge of classes in physical elements of engineering or advanced dynamics. Must be well-grounded in engineering and physics by training and experience. Salary, \$2300–\$2600 a year. Apply by letter giving full personal and professional particulars and enclosing recent photograph. Location, New York, N. Y. Y-2997.

DESIGNER, mechanical engineer, 30–45, with at least 10 years' experience as all-round automatic-machine designer. Salary, \$250–\$300 a month. Apply by letter. Location, New Jersey. Y-3010.

ASSOCIATE PROFESSOR of mechanical engineering to take charge of machine design and kindred subjects. Must have experience in teaching machine design, and should also have practical experience. Salary, \$2500–\$2800 for nine months, beginning September 10, 1938. Southerner preferred. Apply by letter. Location, South. Y-3015.

MECHANICAL ENGINEER, 30–35, with 5 years' experience in centrifugal pumps as applied to marine industry, or experience in drafting room of shipyard laying out pump locations for vessels. Duties will be making up proposals, estimates, etc. Some design work. Apply by letter. Location, East. Y-3028.

MECHANICAL ENGINEER, 30–45, preferably with experience in wood turning. Industrial experience in time and motion study and also machine-design experience helpful. Salary, \$2400–\$4000 a year. Apply by letter. Must be a resident of, or be willing to settle in, northern New England. Y-3029.

MECHANICAL ENGINEER, 28–38, to take charge of gear-cutting department of company manufacturing gears such as spur, spiral, bevel, worms and worm gears. Must have supervisory experience, and be thoroughly acquainted with following equipment: Fellows gear shapers, hobbers, Rotary-type spur-gear cutting machines, Gleason bevel-gear generators, and thread millers. Salary to start, \$45 a week. Apply by letter. Location, New York, N. Y. Y-3034.

MECHANICAL ENGINEER with good technical background and 10 to 15 years' experience in electric-motor field. Initial duties involve helping in reorganization of file and indexing as part of standardization program. Will be in charge of mechanical design of motors and accessories, and should have practical knowledge of modern materials and metallurgy. Apply by letter. Location, Middle West. Y-3038 R-611C.

PRODUCTION AND WORKS MANAGER, about 40, graduate mechanical engineer for well-established internationally known manufacturer of light machinery. Must have good record of achievement, and thorough knowledge of costs, planning, and modern production methods. Apply by letter giving complete information regarding experience, age, nationality, and salary requirements. Location, East. Y-3039.

GRADUATE ENGINEER, 28–32, to organize and teach course in sales engineering under department of general engineering in State university. Must have at least 5 years' experience in responsible sales-engineering position. Salary, \$3000 for nine-month year. Apply by letter. Location, Middle West. Y-3032C.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after July 25, 1938, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Rt = Reinstatement; Re = Reelection; Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

CARTER, DONALD C., Chicago, Ill.
CASSIDY, H., Montreal, Quebec, Canada
CHARIGNON, M. J., Youngstown, Ohio (Re)
GRADISAR, IVAN A., Ambridge, Pa. (Re)
HOLDEN, ALBERT F., Oakland, Calif.
HUNT, MELVIN W., Midland, Mich.
JOHNSON, E. C., JR., New York, N. Y.
KEEFER, K. B., Chicago, Ill. (Rt. & T)
KING, ARTHUR C., Chicago, Ill.
LAMB, A. C., San Francisco, Calif.
LARNER, H. RANDOLPH, Staunton, Va.
LINDE, JAMES E., New York, N. Y.
MACKENZIE, S. T., Philadelphia, Pa.
MAU, GEORGE A., Lakewood, Ohio
OGIER, W. W., JR., New York, N. Y. (Rt & T)
ORNE, C. ORVILLE, East Orange, N. J.
PETERS, HUGH A., Reno, Nevada
ROBERTSON, STEWART F., Baltimore, Md.
ROWELL, JOHN W., Moline, Ill.
SCHILLING, ROY C., Wilmington, Del. (Rt)
SHALLENBERGER, WM. H., Austin, Tex.
SHEPPARD, GEO. W., Cleveland, Ohio
TIRRELL, ROBERT W., New York, N. Y.
TOMPKINS, ROWLAND, Hastings-on-Hudson, N. Y. (Rt)
TREWIN, C. S., Plainfield, N. J.
VICK, R. E., Raleigh, N. C.
WACHSMUTH, ERNEST E., New York, N. Y.
WHARTON, HARRY J., Maracaibo, Venezuela
WHITTAKER, ALBERT E., Boston, Mass. (Rt)
WILLIAMS, ERVIN MAURICE, Spartanburg, S. C.
WOLLMAN, H. L., Berkeley, Calif.
WOODRUFF, EVERETT B., Cincinnati, Ohio
ZAUN, JOHN HENRY, Woodhaven, N. Y.

APPLICATIONS FOR CHANGE OF GRADING

Transfers to Fellow

SCOTT-TAGGART, JOHN, Frinton-on-Sea, England

Transfers to Member

BENNETT, J. S., 3d, Merion, Pa.
DUNCAN, S. F., Los Angeles, Calif.
LINDENMEYR, CARL E., Upper Montclair, N. J.
RAMM, HENRY F., New Britain, Conn.
STARKE, WILLIAM W., Ridgewood, N. J.

A.S.M.E. Transactions for June, 1938

THE June, 1938, issue of the Transactions of the A.S.M.E., which is the *Journal of Applied Mechanics*, contains the following papers:

TECHNICAL PAPERS

Practical Aspects of Turbine Cylinder Joints, by C. B. Campbell
A New Relationship for Use in the Design of Machine Columns, by W. H. Clapp
Correlation of Creep and Relaxation Properties of Copper, by C. C. Davenport
An Improved Method for Calculating Free Vibrations in Systems of Several Degrees of Freedom, by W. M. Dudley
Stress Model of a Complete Airship Structure, by L. H. Donnell, E. L. Shaw, and W. C. Potthoff
Heat Dissipation Through an Annular Disk or Fin of Uniform Thickness, by W. M. Murray

DESIGN DATA

Circular Beams Loaded Normal to the Plane of Curvature, by M. B. Hogan

DISCUSSION

On previously published papers by B. A. Bakhmeteff and N. V. Feodoroff; W. O. Clinedinst; C. M. Kearns and R. M. Guerke; and R. D. Mindlin

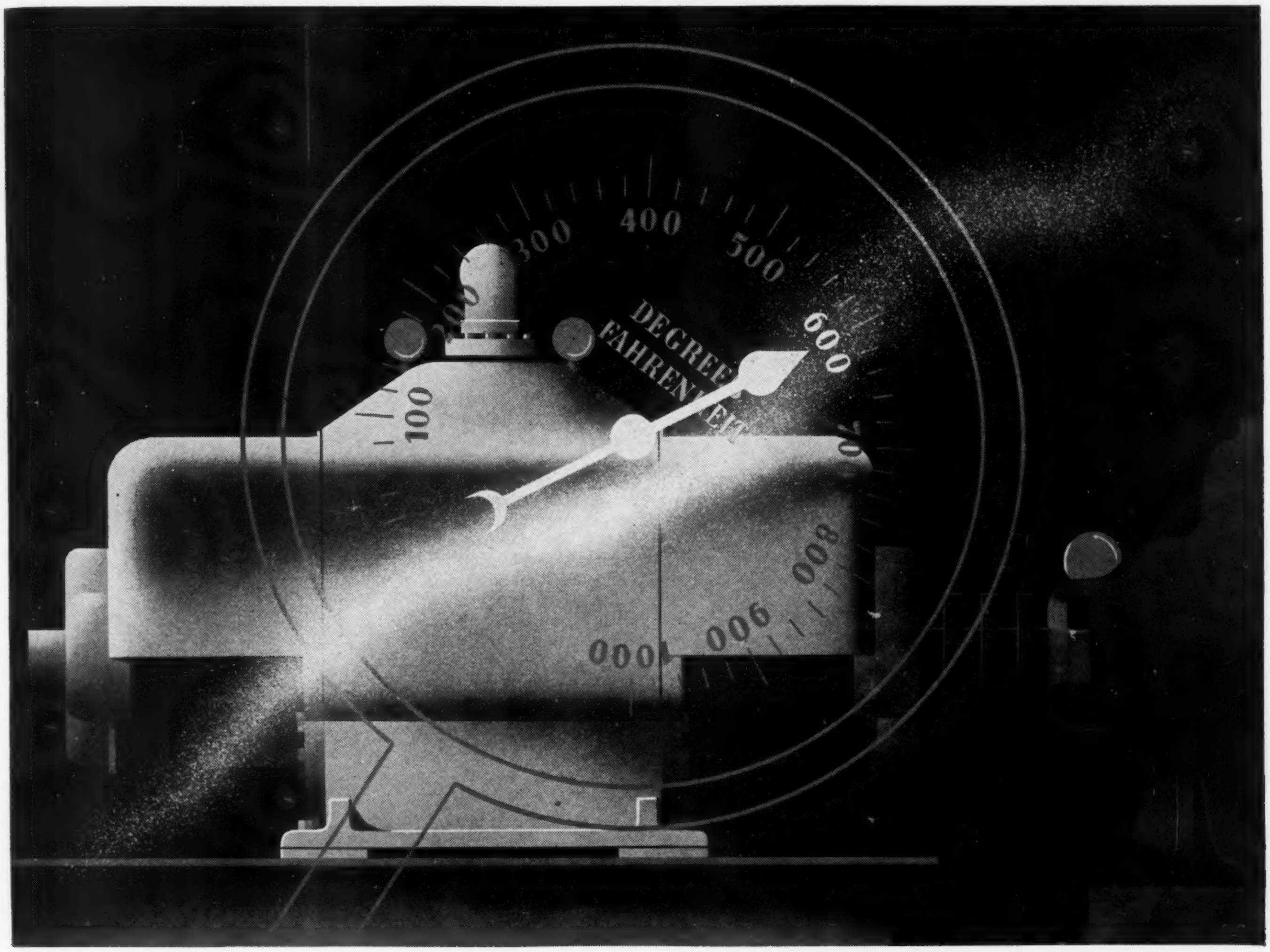
BOOK REVIEWS

By A. M. Wright; J. H. Keenan and E. U. Condon; L. M. Tichvinsky; and J. Ormondroyd.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

BLISS, DUANE L., April 17, 1938
CARDULLO, FORREST E., May 7, 1938
COON, JOHN S., May 16, 1938
EDMANDS, S. S., May 24, 1938
ENGEL, LOUIS G., April 19, 1938
LENZ, EDWARD, March 18, 1938
LEWIS, RICHARD C., May 24, 1938
MEYER, ROBERT M., May 6, 1938
SNEDEN, HORACE J., March 18, 1938
TALLMAN, F. G., April 1, 1938
WAGENSEIL, EDGAR W., May 10, 1938
WEGNER, LEO M. C., May 19, 1938
WINGE, OTTO C., April 20, 1938


100
300
400
500
600
DEGREE
FAHREN

•Keep Informed . . .

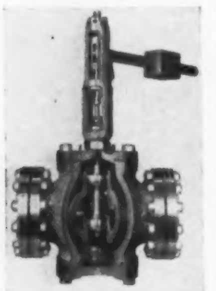
Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as the source.

• ***NEW EQUIPMENT***
• ***BUSINESS CHANGES***
• ***LATEST CATALOGS***

Announcements from current advertisers in MECHANICAL ENGINEERING and the MECHANICAL CATALOG

• *NEW EQUIPMENT*

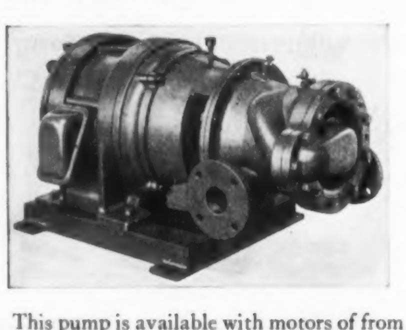
New Cash Standard Valves



For use with Steam, Air, Oil, Water (Hot or Cold), and most any gases—these Series 42 Balanced Lever Valves, announced by A. W. Cash Company, 16th & Eldorado Sts., Decatur, Ill., more than meet the requirements of the fussiest buyers. Type 42-R Valve illustrated, the roller guided top works insuring free valve movement, perfect valve stem alignment, tight seating, longer packing life, and minimum of friction. Valve stem roller guided top and bottom. Nitralloy rollers and roller pins. No lost motion. Double or single seat. Hefty renewable seat rings. Weighty walls. Uniformity throughout and precision machined. Any type inner valve: (1) parabolic type; (2) flat type with bevel seat; (3) V-port type with bevel seat; and (4) V-port type, non seating. Large capacity. Available any size, any materials, $^1/_2''$ to 3" screwed ends; 1" to 12" flanged ends (any type). When used with Series 90 or Series 100 Controllers, they control, automatically, inflow or outflow (reduction, relief, differential pressure, rate of flow, liquid level). Write for Bulletins No. 963 and 965.

New Two Stage "SSUnit" Type Centrifugal Pump

Allis-Chalmers Mfg. Co., Centrifugal Pump Division, Milwaukee, Wis., has supplemented its complete line of single stage "SSUnit" type pumps by adding a $2^1/_2'' \times 1^1/_2''$ two stage "SSUnit" type pump good for heads up to 525 feet at 3550 revolutions. This pump has an efficient capacity range of from 50 to 100 g.p.m. against heads of from 300 to 500 feet. It is bolted to the motor frame by a splash-proof connection piece, the impellers being mounted on the special motor shaft extension, and the motor bearings also being the pump bearings like in their usual "SSUnit" construction.

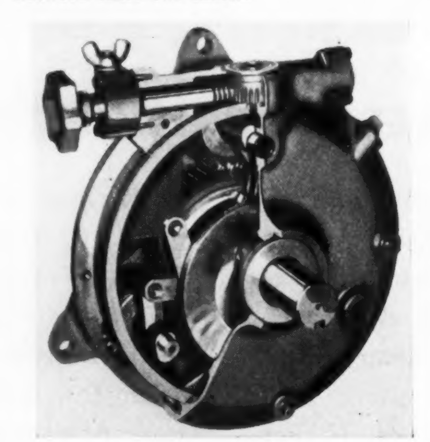


This pump is available with motors of from 10 to 30 horsepower of the standard squirrel cage type, splash-proof or explosion proof types, and is a very adaptable pump for small boiler feed pumps—humidifier pumps in textile mills—air conditioning service—house pumps—small mine pumps—oil gathering, loading and small pipe line pumps and other small capacity, high pressure services.

It operates with unusual smoothness and the efficiency holds up well over a wide range. The standard pump has cast iron casing and cover, and is bronze fitted. The impellers are placed back to back providing axial balance with the suction impeller next to the motor and the discharge passage from the first stage impeller cast integral with the main casing body and communicating with a passage in the cover leading to the inlet of the second stage impeller. This design permits the cover to be taken off, and the inside parts of the pump to be taken out without disconnecting the suction and discharge piping. Descriptive Leaflet 2314 may be obtained from their nearest district office.

Variable Speed Control

The Morse Variable Speed Control is a simple, positive mechanism for governing the speed of output shafts through an infinite number of variations within the range of the unit. With the input shaft operating at the recommended speed of 180 RPM, the Morse Variable Speed Control can be quickly adjusted by a hand set with visible dial to deliver from $1^1/_2$ RPM to 40 RPM through the low speed shaft, or any possible speed in between these two limits.



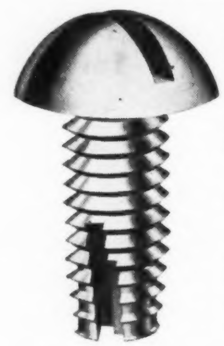
The Variable Speed Control was developed by Morse Chain Co., Ithaca, N. Y., primarily for the milling industry to provide an accurate, dependable, variable speed feeder drive—a simple control of the proportions of feeds and mixes. In this application it has gained immediate recognition as delivering greater efficiency and greater economy.

Since the introduction of the Morse Variable Speed Control, many applications in other industries have presented themselves. As a feeder drive, the unit fits logically into these fields: grain, flour, feed, chemicals, fertilizers, pigments (paints), in stokers, and the handling of any dry materials. As a variable speed drive, this Morse unit is very useful in the control of canning equipment, dairy equipment, washers, bottlers and cappers, light conveyors, oven conveyors.

The construction of the unit is simple, sturdy, and will give long service. It is self-contained, and therefore cannot be affected by dust or dirt conditions. There is not a single bolt, nut, or part inside the case which can become loosened and cause trouble.

The Morse Variable Speed Control unit is easily installed—simply couples to the shaft and bolts on the machine frame by three bolts. Right or left hand units are available.

Thread-Cutting Screws for Use in Plastic Materials



The Shakeproof Lock Washer Company has recently announced the development of the new Shakeproof "Hi-Hook" Thread-Cutting Screw, expressly developed for plastic materials.

A specially designed double width slot gives an acute cutting edge that cuts a clean, sharp thread in all types of plastic compositions, both molded and laminated. This construction materially reduces the high driving torque normally encountered and enables fast, easy driving with a minimum of the breakage common to molded plastics.

Because the screw cuts a standard thread, it may be replaced if necessary by a conventional machine screw of the same size without damaging the tapped hole.

The need for a separate tapping operation or threaded inserts is eliminated, the only requirement being that the screw be inserted in a molded or drilled hole of the proper size and driven home with a hand or power driver.

A free demonstration kit of Shakeproof "Hi-Hook" Thread-Cutting Screws, including an assortment of different sizes and complete instructions for testing, can be had by writing the Shakeproof Lock Washer Company, 2511 North Keeler Avenue, Chicago.

New Electrode for Welding Manganese Steel

The Harnischfeger Corporation of Milwaukee announces Smootharc "Harmang"—another in its long line of Smootharc welding electrodes. Designed for welding on parts subject to heavy impact, such as manganese castings, railroad frogs and crossings, dipper teeth, etc., "Harmang" supplied the necessary toughness and hardness. Its base metal is nickel manganese steel, ranging from 11 to 14% nickel manganese, $3^1/_2$ to $4^1/_2$% nickel. Carbon content is in excess of 1%.

The slag coating which stabilizes the arc and protects the metal against loss of carbon and manganese is kept to a minimum, so as not to interfere with the rapid cooling required to form an austenitic deposit. With cold working such as hammering and peening, the soft manganese deposit becomes an extremely hard martensite layer which offers great resistance to impact and abrasion. Smootharc "Harmang" operates with the work negative and the electrode positive, and is built in sizes from $^1/_8''$ to $^1/_4''$ diameter,

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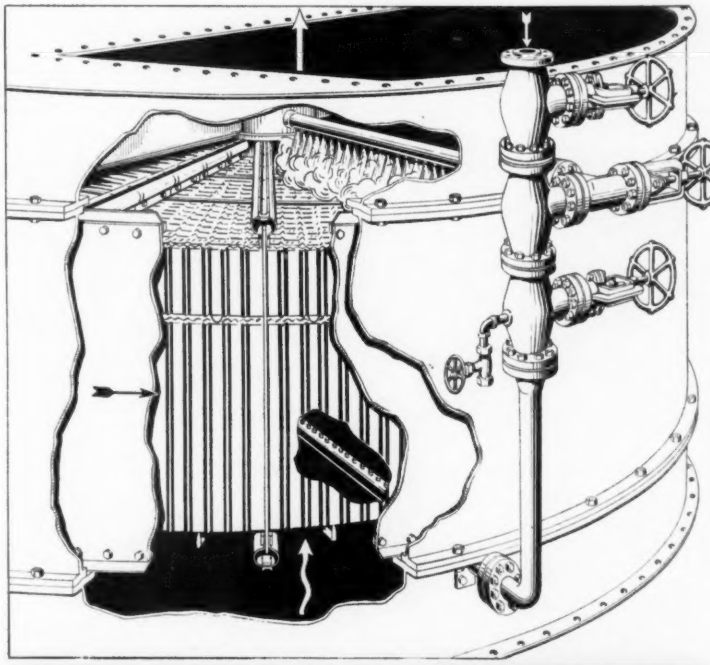
ACCESSIBILITY *for* CLEANING *and* MAINTENANCE

should be an Important Feature in the construction of any air preheater.

The Design of

Ljungstrom



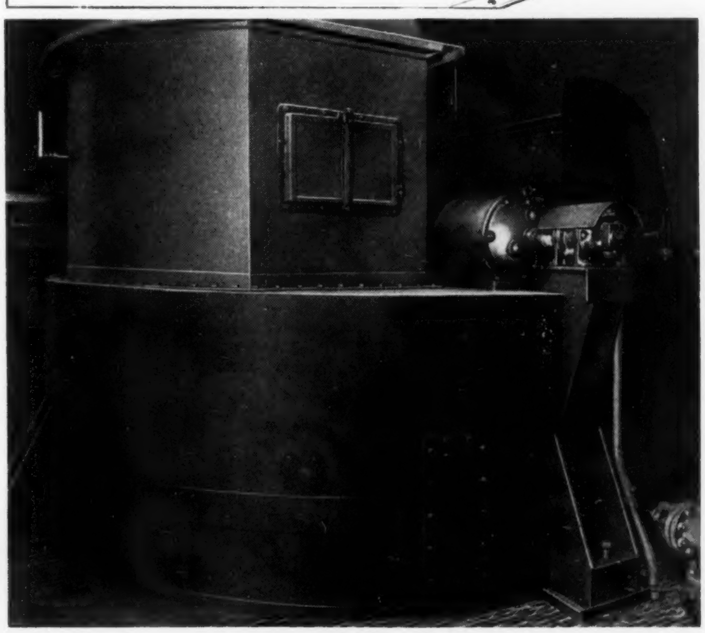
Air Preheaters provides facilities for these essential factors.

Ash and soot accumulations on heating surfaces can be quickly and effectively removed by the soot blowers, without interrupting boiler operation.

The heating elements are readily accessible for inspection and adjustments by means of convenient access doors.

For the same heat recovery, one inch of Ljungstrom heating surface is approximately equivalent to one foot of plate or tubular heating surface.

Other Types *Ljungstrom*



THE AIR PREHEATER CORPORATION

Under the Management of THE SUPERHEATER CO.

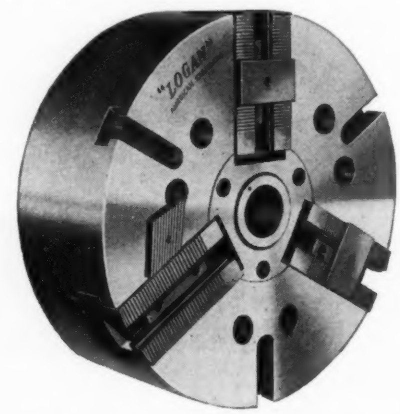
60 East 42nd Street **New York, N. Y.**

A-1238

for use with currents ranging from 90 to 140 amperes. Further information concerning this new welding electrode may be obtained by writing the Harnischfeger Corporation, 4497 W. National Avenue, Milwaukee, Wisconsin.

"Logan" Chucks

Logansport Machine, Inc., Logansport, Ind., announces a complete new line of power operated chucks designed to conform to the specifications of the American Standards Association as formally approved in November 1936. The new "Logan" American Standard Chucks incorporate all the basic features of design and construction which have been developed and proved in previous "Logan" Chucks. The new "Logan" Line is designed and built throughout to insure long life, extreme accuracy and operating efficiency in heavy duty chucking service. Among the more important features of the "Logan" Line is the one-piece cast electric steel body, which is used in all models. The "Logan" Chuck body is cored for light weight and correct balance. Its uninterrupted sidewall, radially reinforced at the points of stress, offers ample resistance to driving and gripping forces; and insures minimum deflection and misalignment. As a result, the new "Logan" Chucks combine extra factors of strength and rigidity with extreme compactness and light weight. Positive pressure lubrication is provided to all working parts to insure long life and efficient operation. All "Logan" Models which are provided with pilot bushing supports are completely sealed against dust, abrasives, cuttings or other foreign matter. This seal is accomplished by the sliding contact maintained between the master jaws and the under side of the pilot bushing support. The dustproof seal and the pressure lubrication provide positive protection to all working parts of the chuck.

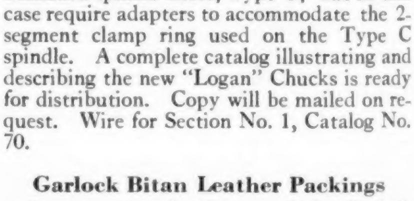


High quality materials are used throughout. All operating parts are heat treated and precision finished. Jaw operating levers are drop forged chrome nickel steel. Lever pins are nickel steel alloy. Levers, lever blocks and draw sleeve are designed with extra large bearing surfaces to resist wear and insure accuracy. The new "Logan" Chucks mount directly on American Standard spindle noses, Types A and B. The elimination of adapters offers decided advantages—accurate concentricity, simple installation and reduced weight and overhang on the spindle. These chucks may also be used on American Standard spindle noses, Type C; but in this case require adapters to accommodate the 2-segment clamp ring used on the Type C spindle. A complete catalog illustrating and describing the new "Logan" Chucks is ready for distribution. Copy will be mailed on request. Wire for Section No. 1, Catalog No. 70.

Garlock Bitan Leather Packings

Announcement has been made by Garlock Packing Co., Palmyra, N.Y., of their new Garlock Bitan Leather Packings which are so treated by an exclusive process that they operate successfully against extreme pressure and under severe conditions. A folder describing these packings has just been issued.

Blower-Oil Pump Units



For use with commercial and industrial oil burners, the Victor-Acme Rotary Blowers, built by the Roots-Connersville Blower Corp., Connersville, Indiana, are being offered in compact self contained units, with fuel oil pump mounted in the blower housing and coupled directly to the blower shaft, so that only one motor or power source is required for the unit. While the illustration shows a direct connected electric motor

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drive, the same blower-oil pump arrangement is available for gasoline engine drive, or flat or multi-V-belt drives.

The Victor-Acme Rotary Positive Blowers are built for air volumes ranging up from 5 to 700 CFM and for pressures of 8 ozs. to 7 or 8 lbs. per square inch. Other styles are produced for larger air volumes and higher pressures. Oil Pumps are supplied in the type and size suitable for the amount and kind of oil used by the burner. The Bulletin 21-B-19 contains a more detailed description and listing of these blowers.

• BUSINESS CHANGES

Standards Department Formed by General Electric

To better co-ordinate activities in the development and application of standards both within the Company and without, General Electric has formed a new Standards Department. This organization will work with the various local, national, and international associations and agencies interested in standards and codes and will also promote the development of standards for use in the Company's engineering and manufacturing department. The new department will be headed by L. F. Adams, who will serve as manager and assistant to Vice President E. O. Shreve. Associated with Mr. Adams will be E. B. Paxton, E. R. Anderson, H. W. Samson, and H. W. Robb.

The formation of the Standards Department centers in one organization the work formerly done by smaller groups throughout the various General Electric plants. At the same time, however, the several standardizing committees already established by the Company will continue to function in the development and design of apparatus in their respective lines.

Timken Appoints David T. Marvel

The Timken Roller Bearing Company announces the appointment of David T. Marvel as Manager of Tube Sales. He will have full charge of the sale of all forms of Timken Seamless Steel Tubing. His headquarters will be at the main office in Canton, Ohio.

John R. Cassell Promoted

John R. Cassell, for many years active in sales promotion work within the engineering reproduction field, was recently promoted from the position of General Sales Manager to that of Vice President in Charge of Sales of the Ozalid Corporation, 354 Fourth Ave., New York, N. Y. Mr. Cassell was at one time associated with the Chicago Office of the McGraw-Hill Publishing Company and has been identified with the architect and engineering supply industry for many years.

New General Manager Fairbanks-Morse Beloit Works

A. E. Ashcraft, Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago, Ill., Vice President in charge of manufacturing, has announced the appointment of A. C. Howard to the position of general manager of the company's Beloit, Wis., plant. This position formerly was held by Mr. Ashcraft in addition to his executive control of all Fairbanks-Morse factories in the United States and Canada.

Mr. Howard has been assistant general manager of the Beloit plant for six years. His association with the company began 22 years ago when he was employed as an inspector at the Canadian Fairbanks-Morse Co., Ltd., Toronto factory, which was then engaged in the manufacture of ammunition for the British Government. He subsequently served as general manager of other Fairbanks-Morse factories, both in the United States and Canada.

Norma-Hoffmann Elects

At a meeting of the Board of Directors of Norma-Hoffmann Bearings Corporation of Stamford, Connecticut, held on April 12, 1938, Walter M. Nones was re-elected President of the company. Odbert P. Wilson was elected Executive Vice President and Treasurer of the company. This action delegates to Mr. Wilson, who has been associated with the company for twenty-four years, the executive duties and responsibilities which Mr. Nones has carried for twenty-seven years. Harold J. Ritter was re-elected Secretary of the company.

L. B. Hampton Made Crane Co. District Manager

L. B. Hampton, prominent in western business circles for a quarter of a century, has been made manager of the Pacific Northwest district of Crane Co., Chicago, succeeding F. A. Nitchy, who is retiring after 46 years service with the company. The district embraces the states of Washington, Idaho, nearly all of Oregon and Utah and parts of Nevada, Montana and Wyoming.

Mr. Nitchy joined Crane Co. in 1887 at Kansas City, Mo., and, but for a four year period from 1889 to 1893, he has been with the company ever since. He went west in 1888, working in both the Los Angeles and San Diego branches of the company, and then joined the Portland, Ore., branch in 1893, becoming manager there April 1, 1898. Mr. Nitchy was both branch and district manager beginning April 1, 1936, and after March 15, 1937, he devoted his entire time to district supervision.

Born at Salt Lake City, Utah, Mr. Hampton joined Crane Co. there in 1903. He became assistant manager of the Salt Lake City branch in 1911 and manager in 1915, remaining in that post until 1937 when he went to Portland, Ore., as branch manager. He is a past president of the Salt Lake City Chamber of Commerce and Rotary Club. The headquarters of the Pacific Northwest district will continue at Portland, Ore. Mr. Hampton's successor as manager of the Portland branch of Crane Co. is Robert C. Smith, who has been assistant manager.

• LATEST CATALOGS

Elesco Economizers

A new 16-page catalog has been issued by Combustion Engineering Co., Inc., 200 Madison Ave., New York, N.Y., dealing with the latest designs and details of Elesco fin-tube economizers. These are of two general designs—Type A in which the ends of the bifurcated tubes are connected by bends with flanged connections, and Type C in which forged return bends are employed. The former type is for use where feedwater conditions make ready access for internal inspection or cleaning desirable and the latter is for use where internal cleaning is not required. The extended surface on both types promotes high efficiency due to the high ratio of gas surface to water surface. The design is such as to provide low draft loss in relation to gas flow and high heat recovery in relation to draft loss. Also, due to the maintenance of effective distribution and velocity of gases at all rates of output and to the absence

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of eddy currents, soot and dust accumulations are reduced to a minimum.

Besides fully describing and illustrating these designs in detail, the catalog discusses factors governing the selection and application of economizers and shows numerous typical installations in modern steam generating units.

Adsco Steam Traps

A new, illustrated, 4 page, two color Bulletin No. 35–86, giving details of construction and installation hook-ups on the ADSCO Vertical Float Type Steam Trap with or without thermostatic air by-pass, is available by addressing the American District Steam Co., North Tonawanda, N. Y., pioneer manufacturers of expansion joints, tile conduit and other steam distribution equipment.

J-M Refractory Products

In a new 20-page engineering data book, Johns-Manville has made available full information on the J-M line of refractory products—including cements, castables and plastics—which this company has developed to fulfill the diversified requirements of modern industrial practice. The descriptive material includes data on the character or base of each product, its highest working temperature, the number of pounds needed to set 1,000 brick or form one cubic foot of construction, and the form in which the product is furnished. How to apply refractory materials so as to obtain the best operating results is an important phase of the subject which the book discusses thoroughly. Explicit directions tell how to prepare the different products for use, and every step in their application is carefully outlined.

The book's most valuable feature—one which will be definitely helpful to the operators of power plants, oil refineries, gas and coke plants, steel mills, lime and cement kilns, iron foundries, furnaces in the non-ferrous metal industries, glass-making equipment, ceramic kilns, incinerators and domestic oil burning and stoker installations—is a comprehensive table which lists separately the various types of heater equipment used in these different industries. For each piece of equipment, the table describes the parts requiring a refractory cement and recommends a specific product for the job. Copies of the book, Form DS Series 700, are available upon request to Johns-Manville, 22 East Fortieth Street, New York N.Y.

Velocity Stage Turbines

Small steam turbines for driving auxiliary machinery, such as generators, pumps, fans, etc., are described in Catalog C issued by the De Laval Steam Turbine Co., Trenton, N. J. These turbines are of the velocity stage type and, when operated at suitable speeds, as in connection with high speed machinery or by the use of speed reducing gears, and exhausting to back pressure, show good efficiency. The design has been specially adapted to the use of high pressure, high temperature steam by locating the steam chest in the upper part of the casing cover, where it is above and well removed from the bearings.

Frequency Records and Indicators

A new 20-page catalog on "Micromax Frequency Recorders and Indicators" has just been issued by the Leeds & Northrup Co. Now that synchronous clocks and synchronous machinery are used so generally, *frequency measurement* is increasingly important not only to public utilities, but to industrial plants that generate their own power, and even to those that buy it. The subject, however, is one on which little literature has been published. In this booklet, therefore, the description of instruments is prefaced with a discussion of considerations responsible for the increasing use of equipment for frequency measurement and for frequency-load control. Illustrations show modern installations in steam, hydro and diesel plants, large and small, as well as in load dispatchers' offices and in laboratories.

To receive a copy, ask Leeds & Northrup Company, 4963 Stenton Avenue, Philadelphia, Pennsylvania, for Catalog N-57-161.

Homo Method for Tempering

A copy of a new, profusely-pictured 36-page catalog, describing the Homo method for tempering, may be obtained by addressing Leeds & Northrup Co., 4963 Stenton Avenue, Philadelphia, Pa. In this new book are shown many varieties of work now being tempered, annealed or normalized in modern Homo furnaces. Reproductions of actual chart records demonstrate the uniformity of Homo heat distribution throughout loads, formerly considered difficult to heat evenly. A cut-away furnace and diagrammatic drawings show the unique Homo design and construction which makes possible this uniformity. And for the first time, a single publication pictures and describes the complete line of modern Homo furnaces. . . for production tempering and for tool tempering; for large and for small loads; for vertical and for horizontal loading; for top efficiency on dense, on semi-dense and on open loads.

Crane Plug Disc Valves

"The Inside Story of Crane Plug Disc Globe and Angle Valves" is the subject of a new, 8-page, two-color booklet just released by Crane Co., 836 South Michigan Avenue, Chicago, Ill. Besides being profusely illustrated there is a full page table which lists the essential characteristics of each member of the Crane plug disc family. "This line of Crane Plug Disc Valves is recommended for throttling, soot blower, blowoff, boiler feed, drip and drain lines or for any other severe service where valves are operated in any but a full open or closed position," says the booklet.

COMING MEETINGS AND EXPOSITIONS

For the next three months

JULY

6–9 National Aeronautical Association, 11th National Championship Model Airplane Contest, Detroit, Michigan.

AUGUST

9–12 American Institute of Electrical Engineers, Annual Pacific Coast Convention, Portland, Oregon.

29–Sept. 7 National Aeronautic Association, 3rd Annual Midwest Soaring Contest, Frankfort, Mich.

September

3–5 National Aeronautical Association, 16th National Air Races, Cleveland, Ohio.

5–9 American Chemical Society, Fall Meeting, Milwaukee, Wis.

27–30 Association of Iron & Steel Engineers, Annual Convention and Iron and Steel Exposition, Cleveland, Ohio.